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SESSION, 1898–1899.

The Academy will meet on Monday evenings at 8 o'clock, from October 3d to June 5th, in the rooms of the American Society of Mechanical Engineers, at **12 West 31st Street.**

[ANNALS N. Y. ACAD. SCI., XI, No. 7, pp. 117 to 126, May 17, 1898.]

DESCRIPTIONS OF DEVONIAN CRINOIDS AND BLASTOIDS FROM MILWAUKEE, WISCONSIN.

STUART WELLER.

(Read February 21, 1898.)

[PLATE XIV.]

THE Devonian strata at Milwaukee, Wisconsin, consist of two distinct formations. The lower of these is the hydraulic limestone which is quarried for the manufacture of cement. In this limestone the fossils generally occur as internal casts and external impressions, though some of the smaller forms are sometimes replaced by pyrite. Lying above the limestone is a bed of soft, blue, easily disintegrated shale, containing some thin bands of harder limestone. In this shale the fossils are abundant and often occur perfectly preserved.

The faunas of the two horizons are markedly different, scarcely a species which occurs in the limestone being present in the shale. In the limestone fauna there are many species identical with those in the Hamilton group as typically developed in New York, while in the shale the species are apparently more nearly allied to species in the Iowan Devonian faunas.

The crinoids and blastoids here described are all from the shale, and while the crinoids are quite different from other members of the genus to which they belong, they are to be compared with species which have been described from Iowa and Missouri rather than with any of the more eastern species.

With the exception of *Pentremitidea filosa* (?) which was collected by Mr. A. W. Slocom, all the specimens were collected by Mr. E. E. Teller, of Milwaukee, and are now in his collection.

Melocrinus nodosus Hall.

(Pl. XIV. Fig. 6.)

1861. *Melocrinites nodosus* Hall, Rep. Prog. Geol. Surv. Wis., p. 19.

1895. *Melocrinus nodosus* Whitfield, Mem. Am. Mus. Nat. Hist., vol. I, p. 48, Pl. V, fig. 14.

Calyx pyriform, truncate at the base, sides straight or slightly convex from the tops of the basals to the arm openings ; cross-section, as seen from above, exclusive of the nodes, obscurely subpentagonal, greatest diameter at the arm bases. The plates of the dorsal cup ornamented with conspicuous nodes.

Basals four, projecting laterally into more or less prominent nodes, columnar facet large, often somewhat depressed between the nodes of the plates. Radials large, heptagonal and hexagonal, strongly nodose. First costals hexagonal, smaller than the radials, strongly nodose; second costals pentagonal or heptagonal, smaller than the first and less strongly nodose. Distichals smaller than the last costals, higher than wide, free beyond the first pair. First interdistichals hexagonal, as large as the first costals and bearing similar nodes, followed by two smaller nodose plates in the second row, one of which often bears a larger node than the other ; in the third row there are two or three smaller plates and above these numerous small plates which lead up to those of the vault. The posterior inter-radius is not differentiated from the other four.

Ventral disk depressed convex or nearly flat, composed of small polygonal nodose plates of nearly equal size ; marked by more or less prominent rounded ambulacral ridges which extend from the arm bases towards the center; and surmounted by the base of a subcentral proboscis whose height cannot be determined.

Remarks. This species, although described, but not illustrated, by Hall in 1861, is not recognized by Wachsmuth and Springer in their recent monograph, it being passed over with the remark that it was described from imperfect casts.[1] The

[1] The North American Crinoidea Camerata. By Chas. Wachsmuth and Frank Springer. Vol. I, p. 294.

specimens used by Hall in his description are recorded as coming from the drift about Milwaukee and also from Iowa City, Iowa. It is possible that Hall included in his species all the nodose forms from Milwaukee, but from a study of a considerable number of specimens I am led to recognize two good species. Whitfield's illustration of the species is drawn from the largest of Hall's type specimens, and, except in its larger size, differs in no essential respects from the one here illustrated.

Although two species and one named variety, of these nodose forms are recognized in the present paper, it is possible that some would prefer to include them all in a single variable species. All the specimens, however, which have come under my observation can be placed without hesitation in one of the two recognized species, *M. nodosus* and *M. subglobosus*, but it is more difficult to separate the variety *spinosus* from the typical specimens of *M. nodosus.* The distinguishing differences between the two species will be pointed out in connection with the description of *M. subglobosus.*

With the exception of the associated *M. subglobosus*, *Melocrinus nodosus* is quite distinct from any other species of the genus. It need only be compared with *M. calvini*[1] from the Devonian of Johnson Co., Ia., and *M. gregeri*[2] from the Devonian of Callaway Co., Mo., and from both of these species it differs in its much more strongly nodose plates.

Melocrinus nodosus var. **spinosus** n. var.

(Pl. XIV. Fig. 2.)

This variety differs from the typical form of the species in its higher and narrower calyx, and in its more pointed spine-like nodes.

[1] Wachsmuth and Springer, N. Am. Crim. Cam., Vol. I, p. 300, Pl. XXII, fig. 6.

[2] Rowley, Am. Geol., Vol. XII, Nov. 1893, p. 303, Pl. XVI, fig. 1.

Melocrinus subglobosus n. sp.

(Pl. XIV. Fig. 1.)

Calyx sub-globular, sides convex from the tops of the basals to the arm openings. Cross section, as seen from above exclusive of the nodes, circular, greatest diameter at about the top of the first costals. The plates of the dorsal cup ornamented with remarkably large nodes, the radials, first costals and first and second interbrachials often bearing nodes whose diameter is nearly equal to the width of the plates. The larger nodes rise abruptly from the general surface of the plates, with subparallel sides and with an elevation equal to their diameter.

Basals four, projecting laterally into more or less prominent nodes, columnar facet large, often somewhat depressed between the nodes of the plates. Radials large, heptagonal and hexagonal, strongly nodose. First costals hexagonal, smaller than the radials, strongly nodose; second costals pentagonal or heptagonal, smaller than the first, bearing a much smaller and lower node. Distichals smaller than the last costals, the second pair free and attached to the first by a conspicuous sub-circular facet with numerous fine radiating ridges. First interbrachials hexagonal in the four regular interradial areas, as large as the first costals, and bearing similar nodes, followed by two smaller plates in the second row, one of which often bears a conspicuous node similar to those of the lower plates and the other with a much lower and smaller inconspicuous node similar to those upon the second costals; above the second row the interradial spaces are filled with numerous smaller plates which lead up to those of the dome. The posterior interradius with a heptagonal nodose anal plate in the first row, similar, except in outline, to the first regular interbrachials, followed by three plates in the second row.

Ventral disk subhemispherical, composed of small, polygonal, nodose plates of nearly equal size, and surmounted by the base of a subcentral proboscis whose height cannot be determined.

Remarks. M. subglobosus is most nearly allied to the associated species *M. nodosus*. It differs from this species: 1. In its subglobose form, with the vault subhemispherical rather than

depressed convex or nearly flat. 2. In its more strongly nodose plates, the nodes in this species being nearly as thick at their bases as the width of the plate of which they are a part, with the sides of the nodes subparallel or even in some cases diverging outward, making the node somewhat club-shaped, being thicker towards its extremity than at its base, while in *M. nodosus* the sides of the nodes always converge outwards. 3. In the presence of three plates rather than two in the second row of interbrachials on the posterior side.

Melocrinus milwaukensis n. sp.

(Pl. XIV. Fig. 7.)

Calyx pyriform, truncated at the base, sides slightly convex from the tops of the basals to the arm openings. Cross-section, as seen from above, obscurely pentagonal. Greatest diameter at the arm bases. All the plates of the dorsal cup convex or ornamented with low, broad, central nodes.

Basals four, moderately nodose, not projecting far beyond the column. Radials large, heptagonal and hexagonal. First costals hexagonal, smaller than the radials, second costals pentagonal or heptagonal, smaller than the first. Distichals much smaller than the last costals, the second or third pair becoming free. First interbrachials in the four regular interradial areas, hexagonal, as large as the first costals, followed by two smaller plates in the second and three still smaller ones in third row, these being followed by small plates which lead up to the interradial plates of the vault. In the posterior interradius the first or anal plate is similar in size to the first interbrachials of the other sides, but is heptagonal in form, being followed by three plates in the second row.

Ventral disk depressed convex or nearly flat, composed of small polygonal nodose plates of nearly equal size; marked by more or less prominent ambulacral ridges extending from the arm openings towards the center; and surmounted by a subcentral proboscis whose height cannot be determined.

Remarks. This species with its associated variety differs from

the two preceding species in having, simply, more or less strongly convex plates in the dorsal cup, instead of the great nodose plates of those species. Both the typical form and the variety agree with *M. subglobosus* in the arrangement of the plates in the posterior interradius, but in general form the species more closely resembles *M. nodosus* and its variety *spinosus.*

Melocrinus milwaukensis var. **rotundus** n. var.

(Pl. XIV. Fig. 4.)

This variety differs from the typical form in being shorter, with more convex plates, in the basals being more strongly nodose, and in the more convex subhemispherical vault.

Pentremitidea filosa Whiteaves (?)

(Pl. XIV. Fig. 3.)

1889. *Pentremitidea filosa* Whiteaves, Cont. Can. Pal., Vol. I, p. 104, Pl. 14, Figs. 1–1b.

Body small, proportion of width to height as 3 to 5. Maximum breadth at or near the base of the radial sinus. Lateral outline subovate, but conical at the base and truncated at the apex; cross section at part of maximum width, decagonal, the sides of the decagon represented by the ambulacral areas, short and concave, the other sides nearly straight or slightly concave.

Basal plates three, two pentagonal and larger than the third, which is quadrangular; about one-fourth as high as the radials. Basal cup strongly trihedral, about as high as wide, and reaching more than half way to the bases of the radial sinuses. Radial plates lanceolate in outline, nearly three times as high as wide; the bodies or undivided portions spread outward more rapidly than the basals, and occupy one-fourth of the total length of the plates. The apices of each of the two adjacent radials are united to form an acute point which projects a little above the summit. Radial sinuses deep, the sides elevated and forming sharp edges, the portion bounding the base of the sinus more

highly elevated into a conspicuous node-like projection. Deltoid plates, with the exception of the posterior one, apical, not visible in a side view. Posterior deltoid small, rhomboidal, not well preserved in the specimen.

Ambulacra linear, narrow, narrowly rounded at the base and about one-half as wide at that point as at the summit. Surface transversely convex, forming a longitudinal depression along each side, the central portion raised not quite to the general level of the radials. The food groove in the center of each ambulacrum deepens and broadens near the summit.

Spiracles five, rather large, the posterior one confluent with the anal opening. The remaining characters of the summit not well preserved.

Surface of the radials ornamented with fine concentric lines which are only visible with a lens.

Remarks. The species here figured and described is with some hesitation identified with Whiteaves *P. filosa.* It differs from that species in its greater proportionate height, the proportions between the width and height in Whiteaves' figure being 3 to 4, while in the Milwaukee species it is 3 to 5; in the higher and more slender basal cup, and in its more conspicuous node-like projections of the radials at the basal margin of the sinus. So far as the Milwaukee specimens have been observed, they are always smaller than Whiteaves' figures.

Pentremitidea milwaukensis n. sp.

(Pl. XIV. Fig. 5.)

Body of medium size, lateral outline subovate, maximum breadth a little below the middle of the radial sinuses. Cross-section at the point of maximum width decagonal, the sides of the decagon represented by the ambulacral areas, short and concave, the other sides longer, nearly straight or slightly concave.

Basal plates three, two pentagonal and larger than the third, which is quadrangular, less than one fifth as high as the radials. Basal cup trihedral, wider than high. Radials lanceolate in outline, a little more than twice as high as wide; the bodies or un-

divided portions spread outward in a nearly horizontal position, occupying about one fifth of the total length of the plates. The apices of each of the two adjacent radials are united to form an acute point which projects a little above the summit. Radial sinuses deep, the sides subparallel, elevated so as to form sharp edges, the portion bounding the base of the sinus more highly elevated than at other points. Deltoid plates apical, not visible in a side view, except on the posterior side, where there is a small rhomboidal plate.

Ambulacra linear, narrowly rounded at the base, and but little wider at the summit than at the base. Surface transversely convex, forming a longitudinal depression along each side, the central portion not raised to the general level of the radials. The food groove along the median line of each ambulacrum deepens and widens near the summit.

Spiracles rather large, the posterior one confluent with the arms.

Surface of the radial plates ornamented with prominent raised concentric ridges which converge downwards towards the lateral sutures.

Remarks. This species is in many respects similar to the last, but differs in its larger size and in its proportionally broader radials and shorter base, giving to the body a fuller appearance. The rounded base of the radial sinus and ambulacra is broader and more obtuse in this species than in the last, and the sides of the ambulacra are more nearly parallel. The concentric ornamentation of sharply elevated ridges upon the radials, is much more conspicuous than in the last species, it being always easily recognized without the aid of a lens.

In the specimen figured the base is not preserved, the outline indicated being taken from another specimen.

THE UNIVERSITY OF CHICAGO,
January 18, 1898.

PLATE XIV.

EXPLANATION OF PLATE XIV.

FIG. 1. *Melocrinus subglobosus* n. sp. p. 119.
FIG. 2. *Melocrinus nodosus* var. *spinosus* n. var. p. 119.
FIG. 3. *Pentremitidea filosa* Whiteaves (?). p. 122.
FIG. 4. *Melocrinus milwaukensis* var. *rotundus* n. var. p. 122.
FIG. 5. *Pentremitidea milwaukensis* n. sp. p. 123.
FIG. 6. *Melocrinus nodosus* Hall. p. 118.
FIG. 7. *Melocrinus milwaukensis* n. sp. p. 121.

Figure 7 of this species represents the basal plates as somewhat larger than they are in the specimen.

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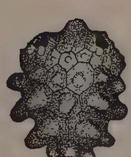

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7

Stuart Weller, del.

[Annals N. Y. Acad. Sci., XI, No. 8. pp. 127–149, May 17, 1898.]

THE EPARTERIAL BRONCHIAL SYSTEM OF THE MAMMALIA.

Geo. S. Huntington.

(Read February 14, 1898.)

[Plates XV–XXVIII.]

INTRODUCTION.

During the past five years I have devoted much time to the examination of the mammalian lung in reference to the structure of the bronchial system and the distribution of the pulmonary vascular supply. In presenting, as a preliminary communication, some of our more important results to the Section at this meeting, I may state that the research is by no means completed, although it comprises the detailed examination of over two hundred lungs from all orders and many families of the mammalia. Some of the facts established appear to me so conclusive that I do not hesitate to direct your attention to the same, especially because they render my interpretation of the mammalian type of bronchial distribution and pulmonary vascular supply different from the one presented by Ch. Aeby in his valuable monograph "Der Bronchialbaum der Säugethiere und des Menschen." Inasmuch as Professor Aeby's views have been adopted, almost without exception, by the authors of current anatomical text-books and incorporated more or less extensively in these volumes, the matter appears to me one of more than common interest and importance.

The preparations upon which the conclusions stated in this paper are based were obtained almost invariably by corrosion of the injected bronchial system and pulmonary artery, the only methods which I believe can be relied upon to give absolute and satisfactory results.

I have appended to this paper a nearly complete bibliographical list of articles on the subject which have appeared since the publication of Professor Aeby's book in 1880.

Before proceeding to details, I may briefly recapitulate the main facts and conclusions which Professor Aeby's work contains on the mammalian lung.

1. Aeby recognizes in each lung a main or "stem"-bronchus which can be followed caudad and dorsad throughout the entire lung, diminishing in size gradually by giving off lateral branches, capable of being separated into a dorsal and ventral set. Aeby defines this as the monopodic type of division.

2. The pulmonary artery follows the same general plan of distribution, the main trunk of each side crossing the bronchus ventro-dorsad and continuing caudad on the dorsal aspect of the stem-bronchus, between the ventral and dorsal lateral branches, which are separated from each other by the vessel.

3. In the human lung and in the lungs of most mammalia the lateral branches on the left side are all given off from the stem-bronchus caudad of the point of intersection of the same with the artery. They constitute, therefore, a group of "Hyparterial bronchi." On the right side in man and in most mammalia a bronchus is given off from the stem-bronchus cephalad of its intersection with the pulmonary artery. Aeby distinguishes this bronchus, which in man supplies the upper lobe of the right lung, as the "Eparterial" bronchus.

4. Inasmuch as the upper lobe of the left and the middle lobe of the right lung is supplied by the first "ventral hyparterial bronchus," Aeby considers them homologous, regarding the "eparterial" bronchus and its resulting lobe (upper right) as an entirely new structure confined to the right lung, and morphologically not represented on the left side.

5. While this arrangement obtains in man and most mammalia, Aeby's researches revealed the fact that certain forms are aberrant in reference to the bronchial and pulmonary vascular distribution.

Aeby classifies the various types determined by himself as follows, the list being completed by the forms examined subsequently by M. Weber:

I. Bronchial Tree with bilateral Eparterial Bronchus.

a. Eparterial Bronchus on both sides bronchial in derivation: *Bradypus, Equus, Elephas, Phoca.*

b. Eparterial Bronchus bronchial in derivation on left side, tracheal on right: *Phocæna communis, Delphinus delphis, Auchenia.*

II. Bronchial tree with Eparterial Bronchus only on right side.

a. Eparterial Bronchus bronchial in derivation: *Monotremata, Marsupalia, Edentata* (except *Bradypus*), *Rodentia* (except *Hystrix*), *Carnivora, Insectivora, Chiroptera, Prosimiæ, Primates.*

b. Eparterial Bronchus tracheal in derivation: *Artiodactyla* (except *Camelus* and *Auchenia*), many *Cetaceans* (*Epiodon australe, Hyperoodon rostratus, Balænoptera rostrata* and *sibbaldii*).

III. Bronchial tree without Eparterial Bronchus. Bilateral hyparterial system: *Hystrix cristata, Balæna mysticetus* and *antipodum.*

IV. Bronchial tree with triple division of Trachea into three unequal Bronchi: *Pontoporia blainvillei.* (Isolated type—not found in any other mammal.)

The above postulates comprise, I believe, the main results of Aeby's research as far as they concern the subject of the present communication. They have been, as already stated, almost universally adopted and have found place, as recognized anatomical facts, in the majority of current text-books on human and comparative anatomy.

Among the subsequent contributions to the morphology of the bronchial tree one deserves special mention, on account of its importance and because it appears to me that it has not received the attention which it deserves. Albert Narath, in 1892, presented a communication to the "Anatomische Gesellschaft," entitled "Vergleichende Anatomie des Bronchialbaumes," published in the "Verhandlungen d. Anat. Gesell. VI. Versammlung, 1892." In this paper Narath controverts a number of Aeby's conclusions very forcibly.

Narath establishes the following propositions, based on extensive comparative and human material :

1. The pulmonary artery in the greater part of its course is placed *laterad* of the stem-bronchus, and does not *cross* the same in Aeby's sense.

2. The pulmonary artery does not influence the structure of the bronchial tree.

3. There is no fundamental difference between the "eparterial" and "hyparterial" bronchi of Aeby.

4. The "eparterial" bronchus is a dorsal (first dorsal) branch, probably originally a lateral branch of the first ventral bronchus shifted upwards on the stem-bronchus.

5. The right eparterial bronchus (when alone present as in man) is represented by an "apical" bronchus on the left side, derived as a lateral branch from the first ventral bronchus.

These important conclusions of Narath will be subsequently again referred to in comparing them with the results obtained by our investigations.

If we now, carefully and without prejudice, examine a large number of corrosion preparations of mammalian lungs, in which the bronchial system and pulmonary artery have been injected, the following facts will reveal themselves :

1. A unity of ground plan can be discerned in all, modified in various forms by :
    a. Migration of one or more secondary bronchi cephalad on the main bronchus, or even on the trachea.
    b. Corresponding changes in the branching of the pulmonary artery.
    c. The appearance, in many forms, of a right accessory (cardiac or azygos) bronchus.
2. If asymmetry exists the right lung is in general the one favored by the greater development and increased calibre and number of the bronchial branches. This physiological precedence of the right over the left lung is characterized by the following facts :

a. The "eparterial" bronchus, if unilateral, is always on the right side.

b. The "cardiac" bronchus is always on the right side.

EXAMINATION OF TYPES.

We may profitably begin our consideration of the mammalian bronchial tree by examining seriatim a number of selected types, subsequently comparing the members of the entire series, in their probable phylogenetic relation to each other, and draw our general conclusions from such comparison.

For reasons, which will be stated later, and which induce us to regard the form as the representative of the primitive mammalian lung, we begin with the type described by Aeby as "Bronchial Tree without Eparterial Bronchus," the complete bilateral hyparterial type.

I. Hystrix cristata—European Porcupine.

Corrosion of bronchial system and pulmonary artery. Columbia University Museum, No. 413. Pl. XV.

The caudal end of the trachea enlarges to a capacious pentagonal bulla or lacuna, slightly compressed dorso-ventrally.

The bronchi, hyparterial in their derivation on both sides and perfectly symmetrical, arise from the tracheal bulla as two main trunks, cephalic and caudal (Pl. XV, *A*, *A*, *B*, *B*). Each trunk divides, in a nearly dichotomous manner, into two nearly equal secondary branches (Pl. XV, *A′*, *A″*, *B′*, *B″*), which in turn give off, by monopodic division, tertiary branches.

1. Cephalic Trunk (Pl. XV, *A*, *A*).
   a. Apical Branch (*A′*) passes to the anterior portion of each lung.
   b. Lateral Branch (*A″*) supplies the central (middle) portion of each lung.
2. Caudal Trunk (Pl. XV, *B*, *B*). Both medial and lateral secondary branches (*B′* and *B″*) ramify in the posterior portion of the lung.

II. a. Taxidea Americana—American Badger.

First specimen; juvenile animal.

Corrosion of bronchial system and pulmonary artery. Columbia University Museum, No. 1254. Pl. XVI.

The tracheal lacuna is large, bullous, rounded, projecting caudad with a blunt rounded terminal cupola between the caudal bronchial trunks.

The primary trunks of right and left side, two in number (Pl. XVI, *A*, *A*, *B*, *B*), arise directly from the expanded tracheal bud. They are, however, compared with those of *Hystrix*, no longer quite symmetrical.

1. Left Lung.

a. Cephalic Trunk (*A*).

Large, directed cephalo-laterad, distributing by monopodic division, secondary branches cephalad and caudad.

b. Caudal Trunk (*B*).

A short wide stem, directed caudo-laterad. It divides, dichotomously, into two main secondary branches, a medial and a lateral (*B′*, *B″*), each of which again divides in a nearly dichotomous manner, the main secondary and the resulting tertiary branches giving off monopodic lateral twigs. (Mixed dichotomous and monopodic type of division.)

2. Right Lung.

a. Cephalic Trunk (*A*).

A short wide stem, directed cephalo-laterad, divides into secondary branches as follows:

α. A slightly smaller apical branch directed cephalo-laterad (*A′*).

β. A somewhat larger lateral branch, directed latero-caudad (Pl. XVI, *A″*). Each secondary branch gives off monopodic tertiary branches.

b. Caudal Trunk. (*B*).

Very short, sessile, directed caudo-laterad. Divides almost immediately into two secondary branches of nearly equal size (*B′*, *B″*), the lateral branch (*B′*) being slightly the larger. Each of

these, as on the left side, gives off two terminal tertiary branches, which are studded with monopodic lateral twigs.

The two tertiary branches resulting from the division of the medial secondary bronchus (B'') are characterized by obtaining their arterial supply through a large trunk passing from the main pulmonary artery ventro-caudad between the cephalic and caudal trunks (angle between A and B), and inclining mesad across the secondary lateral branch of the caudal trunk (B') to reach the terminal divisions of the medial branch of the same trunk (B''). The topography of this arterial vessel (Pl. XVI, C) is entirely characteristic of the usual blood-supply to the infracardiac, or Azygos lobe in other Mammalia (*cf. infra*).

II b. Taxidea Americana—American Badger.

Second specimen, large full-grown male. Corrosion preparation of bronchial system and pulmonary artery. Columbia University Museum, No. 1255. Pl. XVII.

Presents the same characters as the first specimen as regards the tracheal bulla, and the derivation of the cephalic and caudal primary trunks (A and B). The tertiary branches are more fully developed and give off more numerous and larger monopodic lateral twigs.

The main interest, compared with the first specimen, centers around the cephalic trunk (A) of the left lung. The trunk is only slightly smaller than the one of the right side. It divides into a large cephalic or apical branch (A') and a very much smaller lateral branch (A''), while on the right side the primary cephalic trunk A divides into two nearly equal secondary branches (A' and A''). We may, therefore, assume that the large left cephalic bronchus of the younger specimen (Pl. XVI, A) corresponds in the main to A' of the older animal, and that one of the proximal lateral branches develops into branch A'' of the adult.

The asymmetry of the right lung compared with the left is well marked. The main secondary branches (A', A'') derived from the right cephalic trunk (A) exhibit a tendency toward complete separation and individual independence. The arterial

supply of the medial secondary branch (B'') derived from the right caudal trunk (B) presents the same typographical peculiarity found in the younger specimen.

General Consideration of the "Bilateral Hyparterial Type," as Shown in the Preceding Preparations.

1. *Taxidea americana* is a new form, presenting the bilateral hyparterial type, now described in detail for the first time, although I called attention to the peculiarities of the pulmonary structure of this animal in the "Cartwright Lectures," delivered in April 1896.

2. Comparison with the remaining mammalian forms leads me to regard the bilateral hyparterial type as the *primitive condition* of the mammalian lung, whereas Aeby (1) and Wiedersheim (Vergl. Anat. Lehrb., p. 262–266) consider it a complete reduction form, resulting from the bilateral suppression of the "eparterial" bronchus. The reasons for the opinion expressed are as follows:

a. The tracheal lacuna or bulla corresponds to the condition presented by the tracheal bud during the early stages of pulmonary development in mammalian embryos.[1]

b. During the early developmental stages the pulmonary artery passes caudad on each side of the tracheal stalk to the point of division. The subsequent descent of the heart turns the pulmonary trunk ventrad and caudad into the position which it later occupies in relation to the tracheal bifurcation. Hence the original position of the tracheal buds is "hyparterial.

The appearance, therefore, both of the bronchial system and of the pulmonary artery in *Hystrix* and *Taxidea* represents a persistent embryonal type.

3. We may add that this type appears as an exceedingly exceptional one in the mammalian series. In obedience to an

[1] Robinson, Arthur, "Observations on the earlier stages in the development of the Lungs of Rats and Mice," Jour. Anat. and Phys., Vol. xxiii, Pt. ii, January 1889, p. 224.

almost universal law, extension of the bronchial system by migration cephalad of some of the secondary branches brings about asymmetry of the tree and a changed relation of the cephalic primary bronchus to the pulmonary artery.

The only forms in which the bilateral hyparterial type is known to exist are:

Hystrix cristata (Aeby),
Balæna mysticetus and *antipodum* (M. Weber),
Taxidea americana (Huntington).

Turning now to the conditions presented by the remaining mammalia, I have selected the following series of typical modifications, and will present them in the order in which the subsequent general phylogenetic comparison will be made.

III. Canis familiaris—Dog, ♀.

Corrosion preparation of bronchial system and pulmonary artery. Columbia University Museum, No. 1256. Pl. XVIII.

The type presented is the one followed by the vast majority of mammalia, and is defined by Aeby as "bronchial tree with eparterial bronchus only on the right side, bronchial in derivation." There is a well-developed cardiac bronchus (C) supplying the Azygos lobe.

Even a cursory examination of this preparation reveals the fact that, with the exception of the cardiac bronchus, a strict equivalence of bronchial elements exists on the right and left sides, but that their relation to the primary bronchus and the main trunk of the pulmonary artery differs on the two sides.

a. *Left Side.*

The first bronchus is a short, thick stem, hyparterial in position (A), which divides into an apical and a lateral branch (A', A''). Compared with *Hystrix* and *Taxidea*, it is not difficult to recognize in the former the cephalic trunk (A) and in the latter the two secondary branches (A' and A''). The caudal portion of the bronchial tree below the origin of A appears as the

"stem-bronchus" of Aeby, from which the remaining secondary branches are derived. Compared with *Hystrix* and *Taxidea*, we recognize the element B, between the origin of the first hyparterial trunk A, and the origin of the lateral branch B', corresponding to the caudal trunk B of *Hystrix* and *Taxidea.* The lateral branch B' corresponds to the same element in the bronchial system of *Taxidea* and *Hystrix.*

The continuation caudad of the stem-bronchus occupies the site of the secondary caudal branch B'' in *Hystrix* and *Taxidea*, and, like this branch, divides into two nearly equal segments, a medial and a lateral, each of which gives off monopodic dorso-medial and ventro-lateral twigs.

The general comparison, therefore, of the left bronchial system of *Canis* with the bilateral hyparterial type of *Hystrix* and *Taxidea* results as follows :

Hystrix and Taxidea.		*Canis.*
A	=	A
A'	=	A'
A''	=	A''
B	=	B
B'	=	B'
B''	=	B''

Aeby's "stem-bronchus" appears as the result of the following rearrangement and further development :

1. The proximal part, between the bifurcation and the origin of the cephalic trunk A ("primary left bronchus") results from the segmentation and division of the tracheal bulla.

2. The second segment of the stem-bronchus is formed by the element B (caudal trunk) between the origin of A and the derivation of B'.

3. The third segment is continued caudad as the representative of B'' (medial secondary caudal branch), while the lateral branch (B') appears as its secondary derivative. Hence we may regard the typical "stem-bronchus" as it appears in the majority of mammalia in the following light :

"Stem-bronchus" = segmented tracheal bulla + B + B'', medial division.

A and its two secondary divisions A' and A'', B', as well

as the lateral division of B'', appear as lateral (secondary) branches derived from the parent-stem. We have the dichotomous type of division of the primitive form replaced by the monopodic origin of lateral branches from a main parent or stem-bronchus, which condition characterizes the lung of the higher mammalia.

b. *Right Side.*

The first fact noticed is the complete separation of the branches A and A' and the consequent elimination of the primary cephalic trunk A. A' has migrated slightly dorsad and cephalad, so as to arise from the stem-bronchus near the bifurcation. A'' has shifted ventrad and slightly caudad on the stem-bronchus. The interval thus opened between them by the elimination of the trunk A is utilized by the right pulmonary artery to gain the dorso-lateral aspect of the stem-bronchus.

In general there can be no question as to the morphological equivalence, regarding direction, size and lung area supplied, of the branches A' and A'' on right and left sides. The same is true regarding the corresponding branches of the pulmonary artery. To be noted is the early derivation of the arterial trunk accompanying A' on the right side; also the somewhat more pronounced independent character of A', revealed by the greater number and size of its lateral secondary and tertiary derivatives, all facts accentuating the physiological importance which the apical portion of the right lung has assumed.

The caudal segment follows in the main the type presented by the left side. We recognize the same character and derivation of the stem-bronchus.

A new element, not represented on the left side, appears as the cardiac bronchus (C), derived from the stem-bronchus (segment B) caudad and mesad to the separate origin of A''. Comparison with the bronchial tree of *Taxidea* shows that the large artery, accompanying the cardiac bronchus and supplying the Azygos lobe, corresponds topographically to the arterial branch which in *Taxidea* is seen to course ventro-mesad between A and A' and B to reach the bronchi derived from B'.

The cardiac bronchus appears as a secondary structure im-

planted, at somewhat varying levels as we shall see, upon the stem-bronchus of the right side, its appearance being fore-shadowed by the arrangement of the arterial branch (C) of the bilateral hyparterial tree of *Taxidea*.

IV. Dicotyles torquatus—Collared Peccary.

Corrosion of bronchial system and pulmonary artery. Columbia University Museum, No. 1258. Pl. XIX.

This preparation exhibits a good type of the further modifications encountered among the Artiodactyla.

On the left side the entire bronchial distribution is hyparterial, the cephalic trunk A dividing into an apical (A') and a lateral (A'') branch.

On the right side, as in *Canis*, the trunk A disappears by complete segmentation of its secondary branches, and the pulmonary artery crosses dorso-laterad, cephalad of the origin of A'' from the stem-bronchus.

A' has shifted its point of origin, compared with *Canis*, further cephalad and appears as a lateral branch derived from the right side of the trachea.

The distribution of the caudal trunk in symmetrical. The stem-bronchus appears as an especially distinct structure, gradually diminishing in calibre in descent. B' appears as its first lateral branch caudad of the origin of A on the left and A'' on the right side.

The cardiac bronchus and corresponding artery occupy the same position as in *Canis*.

V. Myrmecophaga jubata—Great Ant-Eater.

Corrosion preparation of bronchial system and pulmonary artery. Columbia University Museum, No. 479. Pl. XX.

A further advance in the migration cephalad of the right cephalic trunk A is noted in this preparation.

The entire right trunk, carrying its secondary branches A' and A'', has shifted cephalad on the stem-bronchus, becoming "eparterial," while on the left side the trunk maintains its original position below the artery.

The secondary branch B' on the left side appears reduced.

The cardiac bronchus is large, arising below the origin of B' from the medial margin of the stem-bronchus. The corresponding artery reaches the ventral surface of the cardiac bronchus by crossing obliquely meso-caudad over the stem-bronchus below the origin B'.

VI. Auchenia glama-pacos—Llama-Alpaca.

Corrosion of bronchial system and pulmonary artery. Columbia University Museum, No. 585. Pl. XXI.

The arrangement of the bronchial system on the right side follows in the main the artiodactyl type as represented by *Dicotyles*, with certain minor exceptions to be presently mentioned. The same number and disposition of the main branches is to be noted.

On the left side further extension cephalad of the apical portion of the lung has led to a division of the cephalic trunk A, repeating the one found on the right side.

The lateral branch A'' occupies the position corresponding to the same branch on the right side, below the pulmonary artery. The apical branch A' has migrated cephalad, appearing as an "eparterial" bronchus arising close to the tracheal bifurcation from the left primary bronchus.

The arterial distribution is symmetrical; the vessels accompanying the branch A' are on both sides derived from the beginning of the pulmonary artery, coursing on the ventral aspect of the corresponding bronchus.

This form, noted already by Aeby, constitutes the type which he describes as "bilateral eparterial bronchus, tracheal on right, bronchial on left side."

The cardiac bronchus is also shifted cephalad, arising from

the ventro-mesal aspect of the stem-bronchus, opposite the origin of A'' from the ventro-lateral surface.

The corresponding artery occupies a peculiar position. Instead of winding around the angle between stem-bronchus and A'' caudad of the latter (see preceding types), the artery is derived from the caudal surface of the main pulmonary artery opposite the point where from the cephalic margin the apical vessel accompanying A' takes its origin. The artery descends on the ventral aspect of its bronchus. A similar bronchus is found on the left side, but the corresponding arterial branches are short trunks passing to their distribution from the main pulmonary artery dorsad of the stem-bronchus.

VII. Cebus capucinus—Capuchin Monkey.

Corrosion of bronchial system and pulmonary artery. Columbia University Museum, No. 488. Pl. XXII, Ventral view. Pl. XXIII, Dorsal view.

This type presents a somewhat peculiar arrangement of the cephalic trunks on both sides.

On the right side the separation of the two branches A' and A'' is complete, the pulmonary artery occupying the interval between them. A' has migrated cephalad on the stem-bronchus, becoming "eparterial," and corresponding to the usual mammalian type of the right side.

On the left side the migration of the cephalic trunk A is complete compared with the preceding form (*Auchenia*). It is placed cephalad and dorsad of the point of accession of the main pulmonary artery to the stem-bronchus, and divides into the two secondary branches A' and A''.

We have, therefore, to follow Aeby's nomenclature for the moment, a "bilateral eparterial system." The eparterial bronchus of the right side, as usual, being furnished by the divorced and migrated apical branch A', whereas, on the left side the entire cephalic trunk A, with its secondary branches A' and A'', becomes "eparterial."

This arrangement is exceptional, as the "bilateral eparterial type" is usually symmetrical. It leads, however, directly up to the condition presented by the two following forms, *Cebus niger* and *Phoca*.

The cardiac bronchus is well developed, derived from the right stem-bronchus between A'' and B'.

The artery passes to the cardiac bronchus from the ventral aspect of the main pulmonary artery, before the same has crossed to the lateral aspect of the stem-bronchus, resembling the arterial arrangement noted in *Auchenia*, although a secondary branch (C'') is seen, in the dorsal view, winding around the stem-bronchus in the usual situation of the main artery of the Azygos lobe (Pl. XXIII).

VIII. Cebus niger—Capuchin Monkey.

Corrosion preparation of the bronchial system and pulmonary artery. Columbia University Museum, No. 484. Pl. XXIV, Dorsal view. Pl. XXV, Ventral view.

This type appears as the direct result of further development cephalad of the preceding form.

The cephalic trunks, A, of both sides appear as "eparterial bronchi," each dividing into the characteristic secondary branches A' and A''. On the right side the trunk A has shifted a little further cephalad, nearer to the tracheal bifurcation, than on the left side.

The main caudal branches and the cardiac bronchus are arranged as in the preceding form.

IX. Phoca vitulina—Harbor Seal.

Corrosion of bronchial system and pulmonary artery. Columbia University Museum, No. 584. Pl. XXVI, Ventral view.

This final type presents the complete "bilateral eparterial system," perfectly symmetrical; each cephalic trunk (A) is situated on the stem-bronchus close to the tracheal bifurcation, cephalad of the main pulmonary artery, and divides sym-

metrically into the secondary branches A' and A''. The corresponding arteries are situated ventrad, derived from the pulmonary artery close to its division into right and left main trunks.

In conformity with the complete bilateral symmetry of the tree a cardiac bronchus is not present.

SUMMARY.

If we briefly sum up the main facts just deduced from the examination of these specimens we find that a complete consecutive series can be established, leading from the symmetrical "bilateral hyparterial type" without cardiac bronchus (*Hystrix*), through gradual modifications, to the complete symmetrical "bilateral eparterial type" without cardiac bronchus (*Phoca*).

This series, to obtain a comprehensive view of the main features, may be schematically represented in Pl. XXVII.

Based on this comparison we may incorporate our conclusions in the following propositions :

1. The right and left lung agree, morphologically, in the type of their bronchial distribution.

2. The asymmetry—when observed—is apparent, not real, depending usually upon complete separation of the right cephalic trunk A into its two components A' and A'', and migration of A' cephalad, changing its original relation to bronchial stem and pulmonary artery ; more rarely the asymmetry depends upon the complete migration cephalad of the entire trunk A, carrying the secondary branches A' and A'' (*Myrmecophaga*).

3. Aeby's hypothesis of the morphological equivalence of the middle right and upper left lobe of the human lung is, therefore, incorrect.

The proposition should read :

Right side.		Left side.
Upper + middle lobe	=	upper lobe.
Lower + cardiac lobe	=	lower lobe.

4. The active principle in changing and modifying the architecture of the lung is *not* the pulmonary artery (Aeby), but *mi-*

gration of the cephalic trunk *A*, or of its secondary branch *A′*, usually only on the right side, producing apparent asymmetry. This migration affords an opportunity for more complete development of the resulting terminal bronchial system, and for consequent increase in respiratory area.

5. In the majority of mammals this greater development of respiratory surface is confined to the right side, resulting in the formation of the so-called "eparterial bronchus," and also indicated by the development of a special accessory cardiac bronchus of the right side.

This physiological preponderance of right over left lung is especially well shown by the arrangement of the right lung in artiodactyls (*e.g.*, antelope), where the migration of the cephalic right bronchus has carried the same cephalad, beyond the bifurcation, to the trachea, and where the resulting voluminous upper lobe of the right lung at times extends completely across the mid-line to cap the apex of the more rudimentary left lung.

6. Except, therefore, for purposes of topography we should abandon the distinction of eparterial and hyparterial bronchi, at least to the extent of clearly recognizing the fact that in asymmetrical lungs every right "eparterial" bronchus finds its morphological equivalent among the "hyparterial" bronchi of the left side.

7. The impropriety of ascribing any morphological significance to the number of pulmonary lobes is apparent. The division into lobes is an entirely secondary character, not dependent upon the type of the bronchial distribution, but probably connected with unequal mobility in different segments of the thoracic walls. Lobe-formation is also subject to a considerable range of variation.

8. For the reasons above detailed the primitive type of the mammalian lung is the symmetrical "bilateral hyparterial form," the symmetrical "bilateral eparterial form" representing the *end-stage* in the process of evolution, not the *beginning* (Aeby, Wiedersheim).

9. The primitive type of division is practically dichotomous (*Hystrix*, *Taxidea*).

We can recognize two main trunks on each side, one cephalic, the other caudal. The cephalic trunk supplies the anterior and middle portion of the lung, the main migratory modifications in the different types taking place within its region of distribution. The caudal trunk supplies the posterior and larger portion of the lung.

In the subsequent development of the stem-bronchus and its monopodic type of branching, characteristic of the majority of mammalian lungs, the following factors are active :

a. Complete segmentation of the tracheal bulla, producing the usual bifurcation. This establishes the proximal portion of the "stem-bronchus," and gives to the cephalic primary trunk A the position of a lateral branch derived from the same.

b. The caudal continuation of the stem-bronchus is composed of the primary caudal trunk B and its medial secondary branch B'', the lateral branch B' and subsequently developing lateral accessory branches appearing as the "ventral branches of the stem-bronchus" (Aeby).

c. The cardiac bronchus usually appears as a special accessory branch derived from the stem-bronchus of the right side only (exception *vide supra*, *Auchenia*).

10. In the majority of forms examined the pulmonary artery is not dorsal to the stem-bronchus, except in the terminal part. The position, as Narath has pointed out, is lateral or dorsolateral.

11. Hence, the distinction into "dorsal" and "ventral" branches, separated by the pulmonary artery, should be abandoned.

12. It will be seen that our results agree with the conclusions reached by Narath in regard to the equivalence of the anterior or cephalic branches of right and left side in a symmetrical lungs. We differ from him in our interpretation of the derivation of the "apical bronchus" which he regards as the dorsal branch of the first ventral bronchus.

We differ also as regards the above outlined phylogenetic development of the "stem-bronchus" and its monopodic system of branching.

If we seek for an explanation of the *cause* which leads to the migratory changes of the cephalic bronchus, I admit that we enter the realm of pure hypothesis. At the same time, the very general development throughout the mammalia of this type, with the resulting greater respiratory area of the right lung, may, I think, not improbably be referred to the development of the mammalian form of the systemic and pulmonary arteries. The fact which seems to me to be most significant in this respect is the development of the fourth and fifth embryonic arterial arches (Pl. XXVIII).

We know that with the septal division of the arterial trunk into systemic aorta and pulmonary artery the fifth arches on each side are assigned to the development of the latter vessel,[1] while the remaining arches are partially used in the elaboration of the adult arterial system.

If we consider the significance of the fœtal pulmonary incula-tion it will appear at once that the conditions differ on the right and left sides.

On the left side the greater quantity of the blood thrown from the right ventricle into the left pulmonary artery passes through the Botallian duct directly into the aorta, only a small portion traversing the left pulmonary circulation.

On the right side, however, with the early obliteration of the dorsal segment of the fifth arch, all the blood entering the right pulmonary artery is forced to traverse the entire pulmonary circulation, returning to the left auricle by the pulmonary veins.

I believe that we may properly ascribe to this fœtal circulatory condition a great share in the more marked development of the right as compared with the left lung.

This view is further supported by the conditions found in cases of "situs inversus," where the left lung develops the "eparterial" bronchus (Lit. 6, 8, 9).

[1] It seems preferable, in general considerations, to disregard the existence of the sixth arch, demonstrated by Boas and Zimmerman, on account of the extremely temporary and evanescent character of the interpolated arch.

CONCLUSION.

I have brought this question to the attention of the Academy because I think it is high time to correct the erroneous views founded on Aeby's work. This is the more important, because his theories have been extensively transcribed and his diagrams reproduced in such of the anatomical text-books as deal with the matter at all. I subjoin a list of the anatomical handbooks most commonly in use with a brief statement of their expressions on the subject.

1. **Quain,** "Anatomy," Vol. III, Pt. IV, p. 176-179, follows Aeby's description, giving reproductions or reconstructions of three figures (195, 196, 197) and a somewhat extensive abstract of the text, stating that the right eparterial bronchus in man is not represented on the left side, and that accordingly the lobe which it supplies is also absent, making the upper left the homologue of the middle right lobe.

2. **Morris, Henry**, "Human Anatomy," Phila., 1893, p. 939–940, gives a very indifferent diagram of the ventral view of lungs, heart and pulmonary root, indicating on the right side bronchus, pulmonary artery, and pulmonary vein in the order named cephalocaudad; on the left side in the same order pulmonary artery, bronchus, pulmonary vein.

The text merely repeats this information in a brief statement.

3. **Gray, Henry,** "Anatomy, Descriptive and Surgical." New American Edition from the 13th English Edition, Philadelphia, 1897. P. 1109 gives a diagram (Fig. 706) of the human bronchial tree after Aeby and a brief description founded on Aeby's work. P. 1117 gives in Fig. 710 a faulty view of the ventral aspect of the pulmonary roots, follows it (p. 1118) with the stereotyped description of the order of relations of the structures at the root of the lungs, and concludes (p. 1121) with a xylographic horror purporting to present the roots of the lungs from behind (Fig. 711).

4. **Wiedersheim, Robert,** "Lehrbuch der Vergleichenden Anatomie der Wirbelthiere," 2te Auflage, Jena, 1886, p. 262–266, gives in extenso Aeby's diagrams and conclusions, amplified by the investigations of M. Weber.

5. **Wiedersheim, Robert,** "Elements of the Comparative Anatomy of the Vertebrates" adapted from the 3d German edition, by W. N. Parker, London, 1897, p. 269.

Reproduces Aeby's diagram (Fig. 239), gives a brief resumé of Aeby's conclusions and asserts directly that the anterior lobes of the right and left lung are not homologous, but that the middle right lobe corresponds to the anterior left, and that a want of symmetry is thus created between right and left side, the right lung retaining one more element than the left. This statement is further emphasized by the lettering on fig. 240[a] representing a ventral view of the human lungs.

6. **Joessel, G.,** "Lehrbuch, der topographisch-chirurgischen Anatomie," II, 1. Thorax. Bonn, 1890, p. 60. Gives Aeby's diagram and repeats his conclusions quite fully.

7. **Merkel, Fr.,** "Handbuch der Topographischen Anatomie," Bd. II, Lief. 2, p. 398 and 399, gives Aeby's main conclusions, but also refers to Narath's investigations and gives a schematic figure based on the latter's work. This is the only author who does not accept Aeby's views entirely.

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3. **Narath, Albert.** "Vergleichende Anatomie des Bronchialbaumes." *Verhandl. d. Anat. Gesellschaft.* VI. Versamml. 1892. Pp. 168–175.

4. **Hasse, C.** "Bemerkungen über die Athmung und den Bau der Lungen und über die Form des Brustkorbes bei den Menschen und Säugethieren." *Archiv. f. Anat. u. Entw.* Jahrg. 1893. Heft 5/6. Pp. 293–307.

5. **Hasse, C.** "Ueber den Bau der Menschlichen Lungen." *Ibid.*, Jahrg. 1892. Heft 5/6. Pp. 324–345.

6. **Aeby, Ch.** "Der Bronchialbaum des Menschen bei Situs inversus." *Arch. f. Anat. u. Phys.*, 1882.

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10. **Ewart, William,** "The Bronchi and Pulmonary Blood-vessels, their Anatomy and Nomenclature; with a criticism of Professor Aeby's views on the Bronchial Tree of Mammalia and of Man." London, 1889.

PLATE XV.

Annals N. Y. Acad. Sci., XI, May 18, 1898—11.

PLATE XV.

Hystrix cristata—European Porcupine.

Corrosion of bronchial system and pulmonary artery. Ventral view. Columbia University Museum, No. 413.

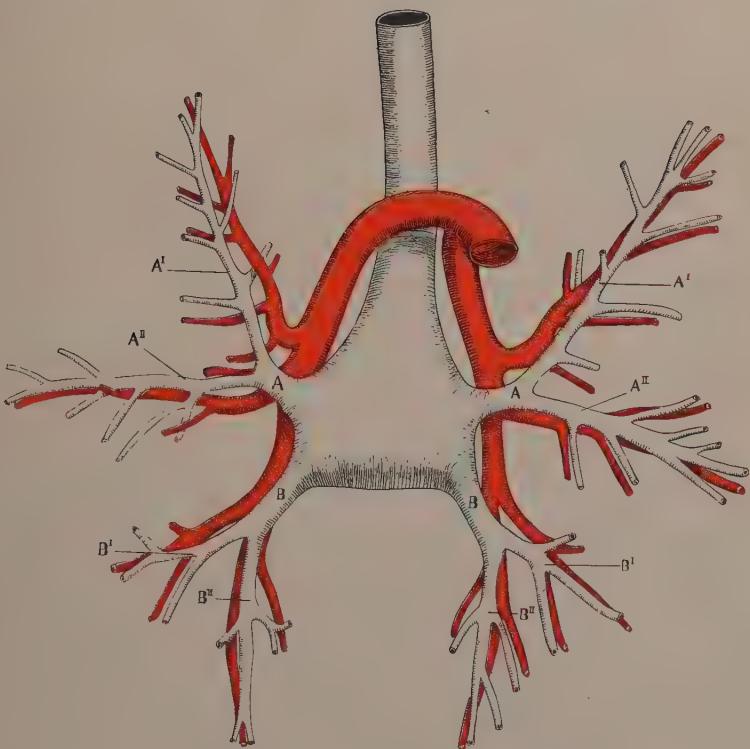

A^I
A^II
A
A
A^I
A^II
B
B
B^I
B^II
B^I
B^II

PLATE XVI.

PLATE XVI.

Taxidea americana—American Badger.

Young animal. Corrosion of bronchial system and pulmonary artery. Ventral view.

Columbia University Museum, No. 1254.

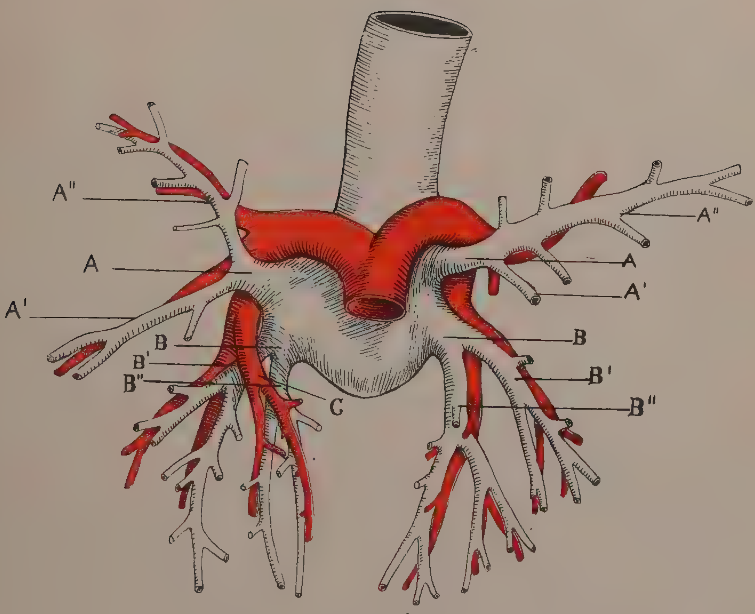

A"
A
A'
B
B'
B"
C
A"
A
A'
B
B'
B"

PLATE XVII

PLATE XVII.

Taxidea americana—American Badger.

Adult ♂. Corrosion of bronchial system and pulmonary artery. Ventral view.

Columbia University Museum, No. 1255.

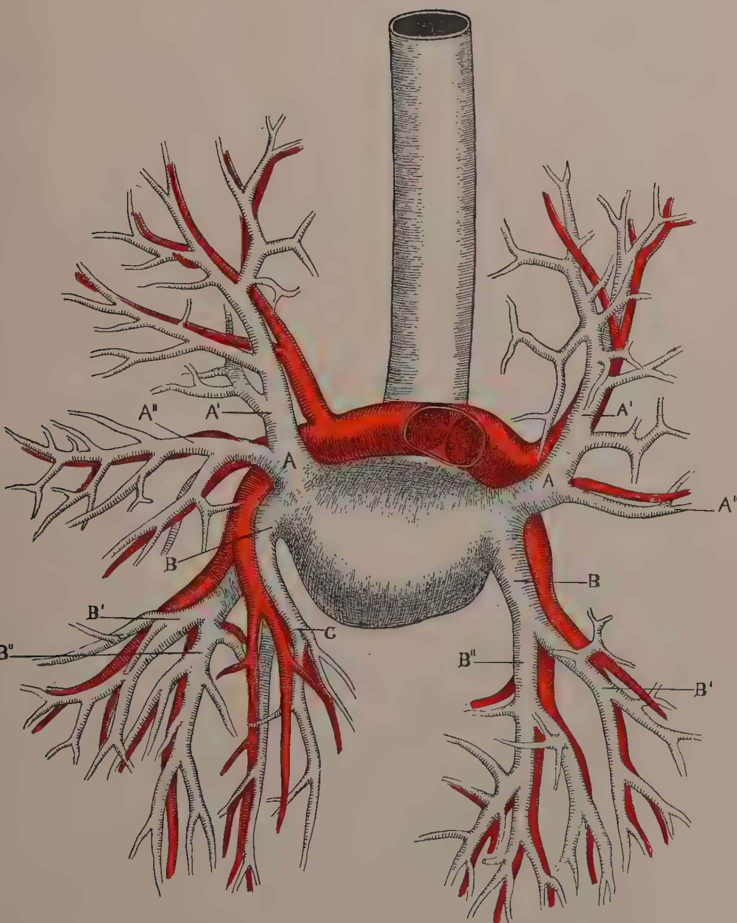

A"
A'
A
B
B'
B"
C
A'
A
A"
B
B"
B'

PLATE XVIII.

PLATE XVIII.

Canis familiaris—Dog.

Corrosion of bronchial system and pulmonary artery. Ventral view. Columbia University Museum, No. 1256.

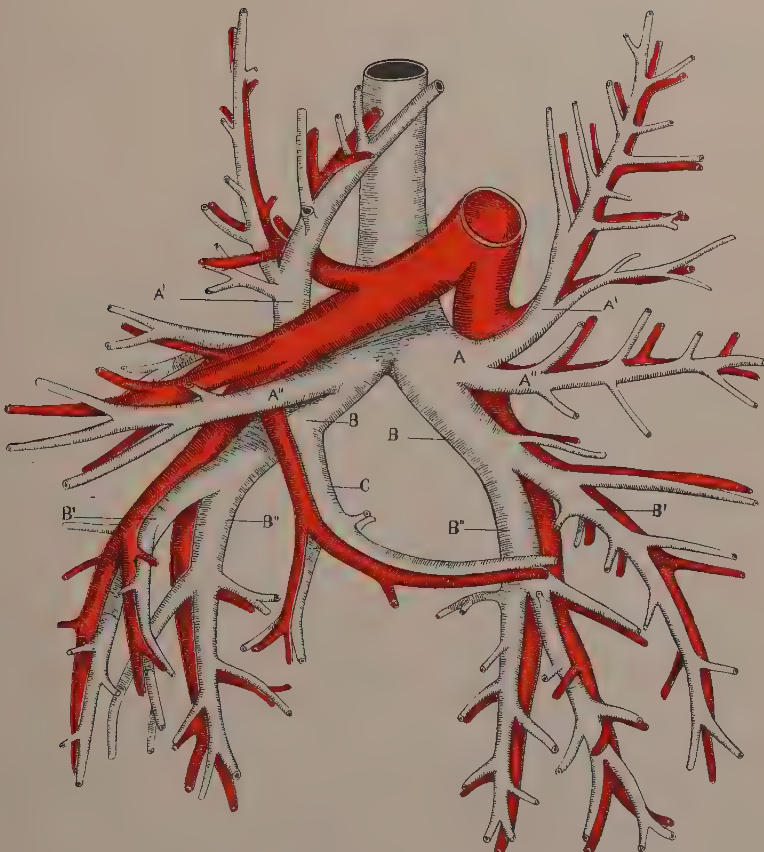

A'
A'
A
A"
A"
B
B
C
B'
B"
B"
B'

PLATE XIX.

PLATE XIX.

Dicotyles torquatus—Collared Peccary.

Corrosion of bronchial system and pulmonary artery. Ventral view. Columbia University Museum, No. 1258.


A^I
A^II
A^I
A
B
B
A^II
B^I
B^I
C
B^II
B^II

PLATE XX.

PLATE XX.

Myrmecophaga jubata—Great Ant-Eater.

Corrosion of bronchial system and pulmonary artery. Ventral view. Columbia University Museum, No. 479.


A'
A''
A
A'
A''
A
B
B
B'
B''
B'
B''
C

PLATE XXI

PLATE XXI.

Auchenia glama-pacos—Llama-Alpaca.

Corrosion of bronchial system and pulmonary artery. Ventral view. Columbia University Museum, No. 585.

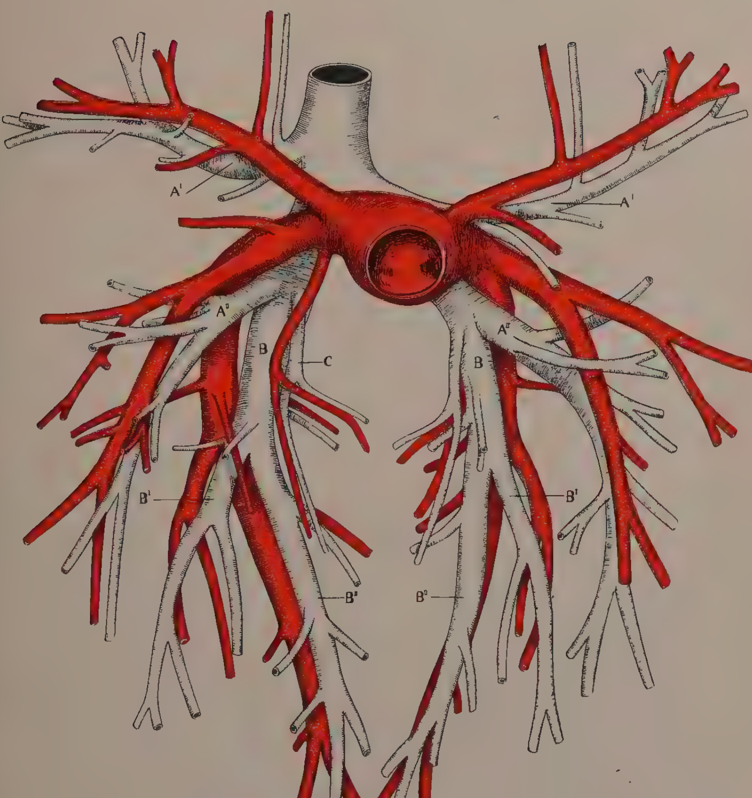

A'
A'
A''
A''
B
C
B
B'
B'
B''
B''

PLATE XXII.

PLATE XXII.

Cebus capucinus—Capuchin monkey.

Corrosion of bronchial system and pulmonary artery. Ventral view. Columbia University Museum, No. 488.

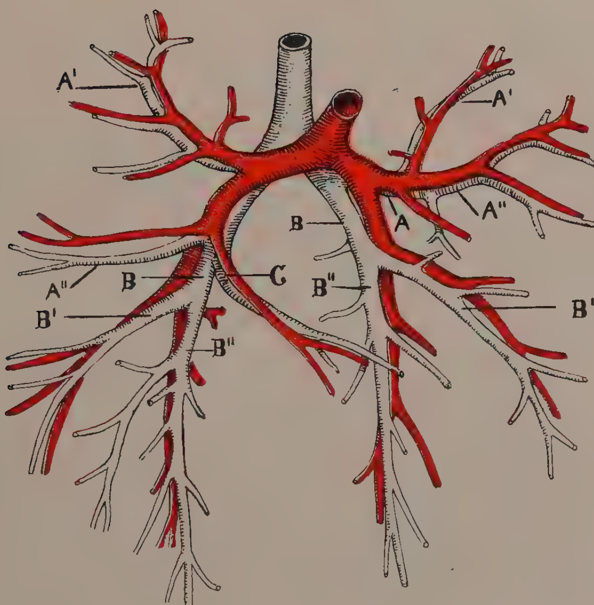

A'
A'
A''
A
B
A''
B
C
B''
B'
B'
B''

PLATE XXIII

Annals N. Y. Acad. Sci., XI, July 29, 1898—12.

PLATE XXIII.

Cebus capucinus—Capuchin monkey.

Corrosion of bronchial system and pulmonary artery. Dorsal view. Columbia University Museum, No. 488.

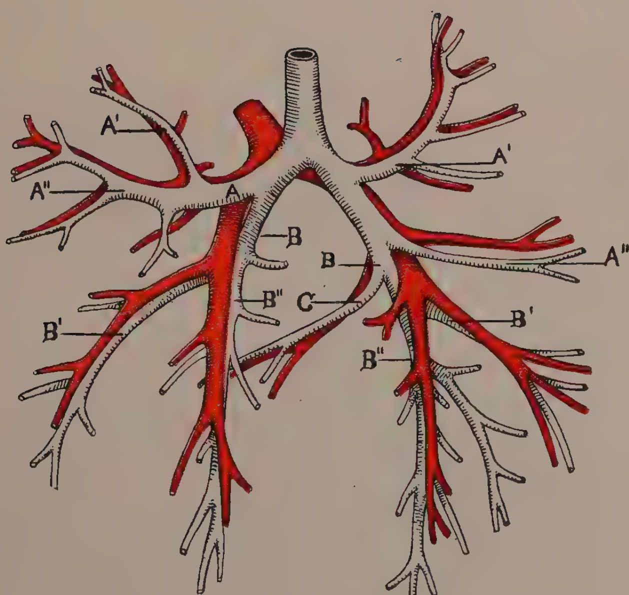

A'
A'
A"
A
B
B
A"
B"
C
B'
B'
B"

PLATE XXIV.

PLATE XXIV.

Cebus niger—Capuchin monkey.

Corrosion of bronchial system and pulmonary artery. Dorsal view. Columbia University Museum, No. 484.


A'
A'
A''
A''
A
A
B
B
B'
B'
C
B''
B''

PLATE XXV.

PLATE XXV.

Cebus niger—Capuchin monkey.

Corrosion of bronchial system and pulmonary artery. Ventral view. Columbia University Museum, No. 484.


A'
A"
A
B
B'
B"
C

PLATE XXVI.

PLATE XXVI.

Phoca vitulina—Harbor Seal.

Corrosion of bronchial system and pulmonary artery. Ventral view. Columbia University Museum, No. 584.

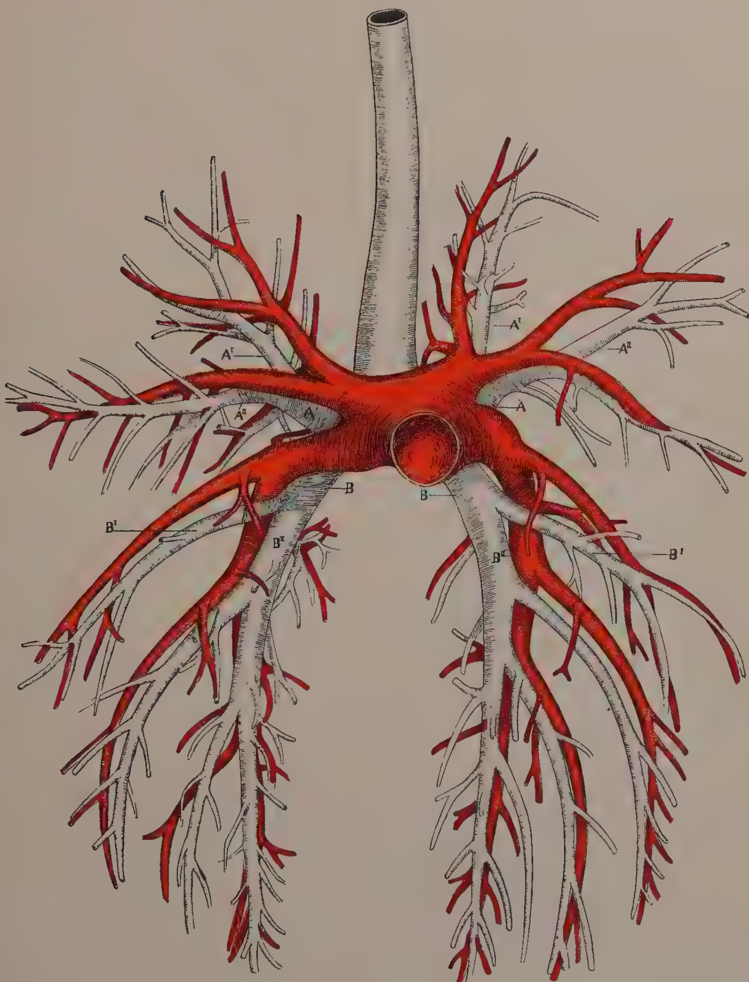
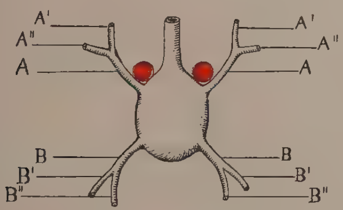

A'
A''
A
A'
A''
A
B
B'
B''
B
B''
B'

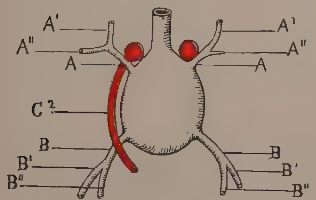
PLATE XXVII.

PLATE XXVII.

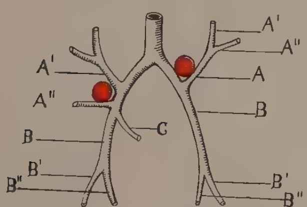
Schematic series, based on preparations described, showing types of mammalian bronchial tree and pulmonary artery.



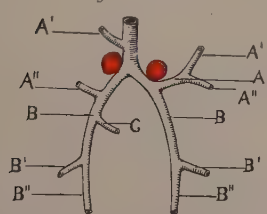
Hystrix cristata.



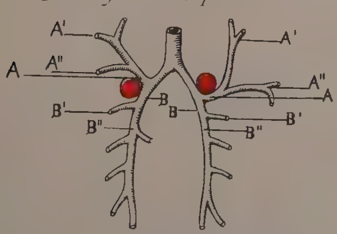
Taxidea Americana.



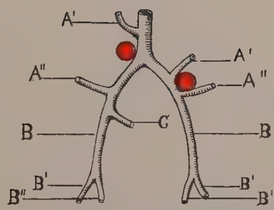
Canis familiaris.



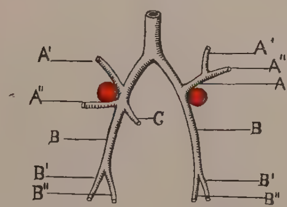
Dicotyles torquatus.



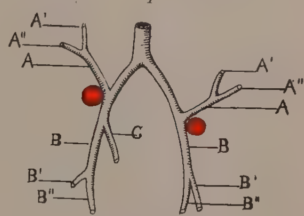
Myrmecophaga jubata.



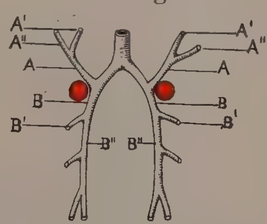
Auchenia glama-pacos.



Cebus capucinus.



Cebus niger.

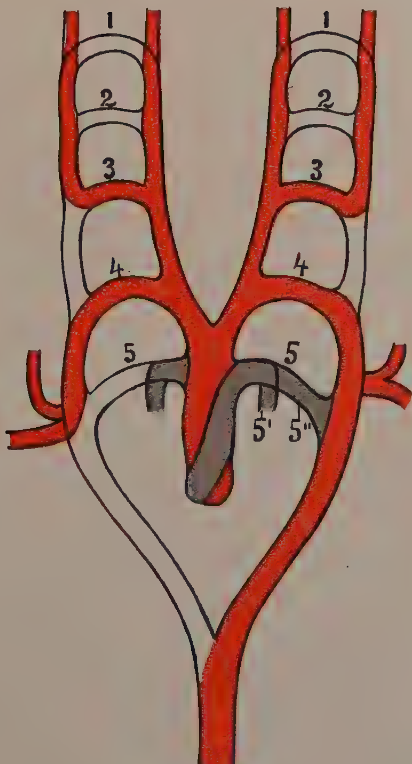


Phoca vitulina.

PLATE XXVIII.

PLATE XXVIII.

Schema showing development of mammalian arterial system.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[ANNALS N. Y. ACAD. SCI., XI, No. 9, pp. 177 to 192, July 29, 1898.]

THE DEBT OF THE WORLD TO PURE SCIENCE.

ANNUAL ADDRESS OF THE RETIRING PRESIDENT.

J. J. STEVENSON.

(Read February 28, 1898.)

THE fundamental importance of abstruse research receives too little consideration in our time. The practical side of life is all-absorbent; the results of research are utilized promptly and full recognition is awarded to the one who utilizes, while the investigator is ignored. The student himself is liable to be regarded as a relic of medieval times, and his unconcern respecting ordinary matters is serviceable to the dramatist and newspaper witlet in their times of need.

Yet every thoughtful man, far away as his calling may be from scientific investigation, hesitates to accept such judgment as accurate. Not a few, engrossed in the strife of the market-place, are convinced that even from the selfish standpoint of mere enjoyment less gain is found in amassing fortunes or in acquiring power over one's fellows than in the effort to solve Nature's problems. Men scoff at philosophical dreamers, but the scoffing is not according to knowledge. The exigencies of subjective philosophy brought about the objective philosophy. Error has led to the right. Alchemy prepared the way for Chemistry, Astrology for Astronomy, Cosmogony for Geology. The birth of inductive science was due to the necessities of deductive science, and the greatest development of the former has come from the trial of hypotheses belonging in the border land between science and philosophy.

My effort this evening is to show that discoveries which have proved all-important in secondary results did not burst forth full-grown; that in each case they were, so to say, the crown of

a structure reared painfully and noiselessly by men indifferent to this world's affairs, caring little for fame, and even less for wealth. Facts were gathered, principles were discovered, each falling into its own place until at last the brilliant crown shone out and the world thought it saw a miracle.

This done, I shall endeavor to draw a moral which it is hoped will be found worthy of consideration.

The heavenly bodies were objects of adoration from the earliest antiquity; they were guides to caravans on the desert as well as to mariners far from land; they marked the beginning of seasons or, as in Egypt, the limits of vast periods embracing many hundreds of years. Maps were made thousands of years ago showing their positions, the path of the sun was determined rudely, the influence of the sun and moon upon the earth was recognized in some degree and their influence upon man was inferred. Beyond these matters man with unaided vision and with knowledge only of elementary mathematics could not go.

Mathematical investigations by Arabian students prepared the means by which, after Europe's revival of learning, one without wealth gave a new life to astronomy. Copernicus, early trained in mathematics, during the last thirty years of his life spent the hours stolen from his work us a clerk and charity physician in mathematical and astronomical studies, which led him to reject the complex Ptolemaic system and to accept in modified form that bearing the name of Pythagoras. Tycho Brahe followed. A mere star-gazer at first, he became an earnest student, improved the instruments employed, and finally secured recognition from his sovereign. For twenty-five years he sought facts, disregarding none, but seldom recognizing economic importance in any. His associate, Kepler, profiting by his training under Brahe, carried the work far beyond that of his predecessors—and this in spite of disease, domestic sorrows and only too frequent experience of abject poverty. He divested the Copernicus hypothethis of many crudities and discovered the laws which have been utilized by astronomers in all phases of their work. He ascertained the causes of the tides; with the aid of the newly invented telescope made studies of eclipses and oc-

cultations, and just missed discovering the law of gravitation. He laid the foundation for practical application of astronomy to every-day life.

In the eighteenth century astronomy was recognized by governments as no longer of merely curious interest and its students received abundant aid. The improvement of the telescope, the discovery of the law of gravitation and the invention of logarithms had made possible the notable advance marking the close of the seventeenth century. The increasing requirements of accuracy led to exactness in the manufacture of instruments, to calculation and recalculation of tables, to long expeditions for testing methods as well as conclusions, until finally the suggestions of Copernicus, the physician, and of Kepler, the ill-fed invalid, became fact, and astronomical results were utilized to the advantage of mankind. The voyager on the ocean, the agriculturist on land, reap benefits from the accumulated observations of three centuries, though they know nothing of the principles or of the laborers by whom the principles were discovered. The regulation of chronometers as well as the fixing of boundary lines between great nations are determined by methods due to slow accumulation of facts, slower development in analysis and calculation, and even slower improvement in instruments.

Galvani's observation that frogs' legs twitch when near a friction machine in operation led him to test the effect of atmospheric electricity upon them. The instant action brought about the discovery that it was due, not to atmospheric influence, but to a current produced by contact of a copper hook with an iron rail. Volta pursued the investigation and constructed the pile which bears his name. With this, modified, Davy, in 1807, decomposed potash and soda, thereby isolating potassium and sodium. This experiment, repeated successfully by other chemists, was the precursor of many independent investigations which directed to many lines of research, each increasing in interest as it was followed.

Volta's crown of cups expanded into the clumsy trough batteries which were finally displaced in 1836 by Daniel's constant battery, using two fluids, one of which was cupric sulphate. De

la Rue observed that as the sulphate was reduced, the copper was deposited on the surface of the outer vessel and copied accurately all markings on that surface. Within two or three years Jacobi and Spencer made the practical application of this observation by reproducing engravings and medals. Thus was born the science of electro-metallurgy. At first mere curiosities were made, then electro-plating in a wider way, the electrotype, the utilization of copper to protect more easily destructible metals, the preparation of articles for ornament and utility by covering baser metals with copper or silver or gold; while now the development of electro-generators has led to wide applications in the reduction of metals and to the saving of materials which otherwise would go to waste.

Oersted in 1819–20, puzzling over the possible relations of voltaic electricity to magnetism, noticed that a conductor carrying an electrical current becomes itself a magnet and deflects the needle. Sturgeon, working along these lines, found that soft iron enclosed in a coil, through which a current passes becomes magnetic, but loses the power when the current ceases. This opened the way for our own Henry's all-important discovery of the reciprocating electro-magnets and the vibrating armature—the essential parts of the magnetic telegraph. Henry actually constructed a telegraph in 1832, winding the wires around his class-room in Albany and using a bell to record the making and breaking signals. Here, as he fully recognized, was everything but a simple device for receiving signals.

Several years later, Professor Morse, dreaming night and day of the telegraph, was experimenting with Moll's electro-magnet and finding only discouragement. His colleague, Professor Gale, advised him to discard the even then antiquated apparatus and to utilize the results given in Henry's discussion. At once the condition was changed and soon the ingenious recording instrument bearing Morse's name was constructed. Henry's scientific discoveries were transmuted by the inventor's ingenuity into substantial glory for Morse, and proved a source of inconceivable advantage to the whole civilized world. Steinhal's discovery that the earth can be utilized for the return current com-

pleted the series of fundamental discoveries, and since that time everything has been elaboration.

Oersted's discovery respecting the influence of an electric current closely followed by that of Arago in the same direction opened the way for Faraday's complete discovery of induction, which underlies the construction of the dynamo. This ascertained, the province of the inventor was well defined, to conjure some mechanical appliance whereby the principle might be utilized. But here, as elsewhere, the work of discovery and that of invention went on almost *pari passu*; the results of each increased those of the other. The distance from the Clark and Page machines of the middle '30's, with their cumbrous horseshoe magnets and disproportionate expenditure of power, to the Siemens machine of the '50's was long, but it was no leap. In like manner, slow steps marked progress thence to the Gramme machine, in which one finds the outgrowth of many years of labor by many men, both investigators and inventors. In 1870, forty years after Faraday's announcement of the basal principle, the stage was reached whence progress could be rapid. Since that time the dynamo has been brought to such stage of efficiency that the electro-motor seems likely to displace not merely the steam engine, but also other agencies in direct application of force. The horse is passing away and the trolley road runs along the country highway; the longer railways are considering the wisdom of changing their power; cities are lighted brilliantly where formerly the gloom invited highwaymen to ply their trade; and even the kitchen is invaded by new methods of heating.

Long ago it was known that if the refining of pig iron be stopped just before the tendency to solidify became pronounced the wrought iron is more durable than that obtained in the completed process. This imperfectly refined metal was made frequently, though unintentionally and ignorantly. A short railroad in southwest Pennsylvania was laid in the middle 60's with iron rails of light weight. A rail's life in those days rarely exceeded five years; yet some of those light rails were in excellent condition almost fifteen years afterwards, though they had carried a heavy coke traffic for several years. But this process

was uncertain, and the best puddlers could never tell when to stop the process in order to obtain the desired grade.

When a modification of this refining process was attempted on a grand scale almost contemporaneously by Martien, in this country, and Bessemer, in England, the same uncertainty of product was encountered—sometimes the process was checked too soon, at others pushed too far. Here the inventor came to a halt. He could use only what was known and endeavor to improve methods of application. Under such conditions the Bessemer process was apparently a hopeless failure. Another, however, utilized the hitherto ignored work of the closet investigator. The influence of manganese in counteracting the effects of certain injurious substances and its relation to carbon when present in pig iron were understood as matters of scientific interest. Mushet recognized the bearing of these facts and utilized them in changing the process. His method proved successful, but with thorough scientific forgetfulness of the main chance, he neglected to pay some petty fees at the Patent Office and so reaped neither profit nor popular glory for his work.

The Mushet process having proved the possibility of immediate and certain conversion, the genius of the inventor found full scope. The change in form and size of the converter, the removable base, the use of trunnions and other details, largely due to the American, Holley, so increased the output and reduced the cost that Bessemer steel soon displaced iron and the world passed from the age of iron into the age of steel.

Architectural methods have been revolutionized. Buildings, ten stories high, are commonplace ; those of twenty no longer excite comment, and one of thirty arouses no more than a passing pleasantry respecting possibilities at the top. Such buildings were almost impossible a score of years ago, and the weight made the cost prohibitive. The increased use of steel in construction seems likely to preserve our forests from disappearance.

In other directions the gain through this process has been more important. The costly, short-lived iron rail has disappeared and the durable steel rail has taken its place. Under the

moderate conditions of twenty-five years ago iron rails scarcely lasted more than five years; in addition the metal was soft, the limit of load was reached quickly, and freight rates, though high, were none too profitable.

But all changed with the advent of steel rails as made by the American process. Application of abstruse laws discovered by men unknown to popular fame enabled inventors to improve methods and to cheapen manufacture until the first cost of steel rails was less than that of iron. The durability of the new rails and their resistance to load justified increased expenditure in other directions to secure permanently good condition of the road bed. Just here, our fellow member, Mr. P. H. Dudley, made his contribution, whose importance can hardly be overestimated. With his ingenious recording apparatus it is easy to discover defects in the roadway and to ascertain their nature, thus making it possible to devise means for their correction and for preventing their recurrence. The information obtained by use of this apparatus has led him to change the shape and weight of rails, to modify the type of joints and the methods of ballasting, so that now a roadbed should remain in good condition and even improve during years of hard use.

But the advantages have not inured wholly to the railroad companies. It is true that the cost of maintenance has been reduced greatly; that locomotives have been made heavier and more powerful; that freight cars carry three to four times as much as they did twenty-five years ago, so that the whole cost of operation is very much less than formerly. But where the carrier has gained one dollar the consumer and shipper have gained hundreds of dollars. Grain and flour can be brought from Chicago to the seaboard as cheaply by rail as by water; the farmer in Dakota raises wheat for shipment to Europe; coal mined in West Virginia can be sold on the docks of New York at a profit for less than half the freight rate of twenty-five years ago. Our internal commercial relations have been changed and the revolution is still incomplete. The influence of the Holley-Mushet-Bessemer process upon civilization is hardly inferior to that of the electric telegraph.

Sixty years ago an obscure German chemist obtained an oily liquid from coal-tar oil, which gave a beautiful tint with calcium chloride; five years later another separated a similar liquid from a derivative of coal-tar oil. Still later, Hofmann, then a student in Liebig's laboratory, investigated these substances and proved their identity with an oil obtained long before by Zinin, from indigo, and applied to them all Zinin's term, Anilin. The substance was curiously interesting and Hofmann worked out its reactions, discovering that with many materials it gives brilliant colors. The practical application of these discoveries was not long delayed, for Perkins made it in 1856. The marvelous dyes, beginning with Magenta and Solferino, have become familiar to all. The anilin colors, especially the reds, greens and blues, are among the most beautiful known. They have given rise to new industries and have expanded old ones. Their usefulness has led to deeper studies of coal-tar products, to which is due the discovery of such substances as antipyrin, phenacetin, ichthyol and saccharin, which have proved so important in medicine.

One is tempted to dwell for a little upon Meteorology, that border land where physics, chemistry and geology meet, and to speak of the Signal Service system, the outgrowth of studies by an obscure school teacher in Philadelphia, but the danger of trespassing too far upon your endurance makes proper only this passing reference.

While men of wealth and leisure wasted their energies in literary and philosophical discussions respecting the nature and origin of things, William Smith, earning a living as a land surveyor, plodded over England, anxious only to learn, in no haste to explain. His work was done honestly and slowly; when finished as far as was possible with his means, it had been done so well that its publication checked theorizing and brought men back to study. His geological map of England was the basis upon which the British Survey began preparation of the detailed sheets, showing Britain's mineral resources.

In our country Vanuxem and Morton early studied the New Jersey Cretaceous and Eocene, containing vast beds of marl.

Scientific interest was aroused, and eventually a geological survey of the State was ordered by the Legislature. The appropriation was insignificant, and many of the legislators voted for it, hoping that some economic discovery might be made to justify their course in squandering the people's money. Yet there were lingering doubts in their minds and some found more than lingering doubts in the minds of their constituents. But when the marls were proved to contain materials which the chemist, Liebig, had shown to be all-important for plants, the conditions were changed and criticism ceased. The dismal sands of eastern New Jersey, affording only a scanty living for pines and grasses, were converted by application of the marl into gardens of unsurpassed fertility. Vanuxem's study of the stratigraphy and Morton's study of the fossils had made clear the distribution of marls and the survey scattered the information broadcast.

Morton and Conrad, with others scarcely less devoted, labored in season and out of season to systematize the study of fossil animals. There were not wanting educated men who wondered why students of such undoubted ability wasted themselves in trifling employment instead of doing something worthy of themselves so as to acquire money and fame. Much nearer to our own time, there were wise legislators who questioned the wisdom of "wasting money on pictures of clams and salamanders," though the same men appreciated the geologist who could tell them the depth of a coal bed below the surface. But the lead diggers of Illinois and Iowa long ago learned the use of palæontology, for the "lead fossil" was their guide in prospecting. The importance and practical application of this science, so largely the outgrowth of unappreciated toil in this country as well as in Europe, is told best in Professor Hall's reply to a patronizing politician's query, "And what are your old fossils good for?" "For this. Take me blindfolded in a balloon; drop me where you will; if I can find some fossils, I'll tell you in ten minutes for what mineral you may look and for what mineral you need not look."

Many regard Botany as a pleasing study, well fitted for women and dilletanti, but hardly deserving attention by strong men.

Those who speak thus only exercise the prerogative of ignorance, which is to despise that which one is too old or too lazy to learn. The botanist's work is not complete when the carefully gathered specimen has been placed in the herbarium with its proper label. That is but the beginning, for he seeks the relation of plants in all phases. In seeking these he discovers facts which often prove to be of cardinal importance. The rust which destroys wheat in the last stage of ripening, the disgusting fungus which blasts Indian corn, the poisonous ergot in rye, the blight of the pear and other fruits fall as much within the botanist's study as do the flowers of the garden or the sequoias of the Sierra. Not a few of the plant diseases which have threatened famine or disaster have been studied by botanists, unknown to the world, whose explanations have led to palliation or cure.

The ichthyologist, studying the habit of fishes, discovered characteristics which promptly commended themselves to men of practical bent. The important industry of artificial fertilization and the transportation of fish eggs, which has enabled man to restock exhausted localities and to stock new ones, is but the outgrowth of closet studies which have shown how to utilize Nature's superabundant supply.

The entomologist has always been an interesting phenomenon to a large part of our population. Insects of beauty are attractive, those of large size are curious, while many of the minuter forms are efficient in gaining attention. But that men should devote their lives to the study of unattractive forms is to many a riddle. Yet entomology yields to no branch of science in the importance of its economic bearings. The study of the life habits of insects, their development, their food, their enemies, a study involving such minute details as to shut men off from many of the pleasures of life and to convert them into typical students, has come to be so fraught with relations to the public weal that the State Entomologist's mail has more anxious letters than that of any other officer.

Insects are no longer regarded as visitations from an angry Deity, to be borne in silence and with penitential awe. The intimate study of individual groups has taught in many cases how

to antagonize them. The scale threatened to destroy orange culture in California; the Colorado beetle seemed likely to ruin one of our important food crops; minute aphides terrified raisers of fruit and cane in the Sandwich Islands. But the scale is no longer a frightful burden in Califarnia; the potato bug is now only an annoyance, and the introduction of lady birds swept aphides from the Sandwich Islands. The gypsy moth, believed for more than a hundred years to be a special judgment, is no longer thought of as more than a very expensive nuisance. The curculio, the locust, the weevil, the chinch bug and others have been subjected to detailed investigation. In almost all cases methods have been devised whereby the ravages have been diminished. Even the borers which endangered some of the most important timber species are now understood and the possibility of their extermination has been changed into probability.

Having begun with the "infinitely great," we may close this summary with a reference to the "infinitely small." The study of fermentation processes was attractive to chemists and naturalists, each claiming ownership of the agencies. Pasteur, with a patience almost incredible, revised the work of his predecessors and supplemented it with original investigations, proving that a very great part of changes in organic substances exposed to the atmosphere are due primarily to the influence of low animals or plants whose germs exist in the atmosphere.

One may doubt whether Pasteur had any conception of the possibilities hidden in his determination of the matters at issue. The canning of meats and vegetables is no longer attended with uncertainty, and scurvy is no longer the bane of explorers; pork, which has supplied material for the building of railroads, the digging of canals, the construction of ships, can be eaten without fear. Flavorless butter can be rendered delicious by introduction of the proper bacteria; sterilized milk saves the lives of many children; some of the most destructive plagues are understood and the antidotes are prepared by the culture of antagonistic germs; antiseptic treatment has robbed surgery of half its terrors and has rendered almost commonplace opera-

tions which less than two decades ago were regarded as justifiable only as a last resort. The practice of medicine has been advanced by outgrowths of Pasteur's work almost as much as it was by Liebig's chemical investigations more than half a century ago.

In this review, the familiar has been chosen for illustration in preference to the wonderful, that your attention might not be diverted from the main issue, that the foundation of industrial advance was laid by workers in pure science, for the most part ignorant of utility and caring little about it. There is here no disparagement of the inventor; without his perception of the practical and his powers of combination the world would have reaped little benefit from the student's researches. But the investigator takes the first step and makes the inventor possible. Thereafter the inventor's work aids the investigator in making new discoveries to be utilized in their turn.

Investigation, as such, rarely receives proper recognition. It is usually regarded as quite a secondary affair in which scientific men find their recreation. If a geologist spends his summer vacation in an effort to solve some perplexing structural problem he finds on his return congratulations because of his glorious outing; the astronomer, the physicist and the chemist are all objects of semi-envious regard because they are able to spend their leisure hours in congenial amusements; while the naturalist, enduring all kinds of privation, is not looked upon as a laborer because of the physical enjoyment which most good people think his work must bring.

It is true that investigation, properly so-called, is made secondary, but this because of necessity. Scientific men in government service are hampered constantly by the demand for immediately useful results. Detailed investigation is interrupted because matters apparently more important must be considered. The conditions are even more unfavorable in most of our colleges and none too favorable in our greater universities. The "literary leisure" supposed to belong to college professors does not fall to the lot of teachers of science, and very little of it can be discovered by college instructors in any department. The

intense competition among our institutions requires that professors be magnetic teachers, thorough scholars, active in social work, and given to frequent publication, that being prominent they may be living advertisements of the institution. How much time, opportunity or energy remains for patient investigation some may be able to imagine.

The misconception respecting the relative importance of investigation is increased by the failure of even well-educated men to appreciate the changed conditions in science. The ordinary notion of scientific ability is expressed in the popular saying that a competent surgeon can saw a bone with a butcher knife and carve a muscle with a handsaw. Once, indeed, the physicist needed little aside from a spirit lamp, test tubes and some platinum wire or foil; low power microscopes, small reflecting telescopes, rude balances and home-made apparatus certainly did wonderful service in their day; there was a time when the finder of a mineral or fossil felt justified in regarding it as new and in describing it as such, when a psychologist needed only his own great self as a basis for broad conclusions respecting all mankind. All of that belonged to the infancy of science, when little was known and any observation was liable to be a discovery, when a Humboldt, an Arago or an Agassiz was possible. But all is changed; workers are multiplied in every land; study in every direction is specialized; men have ceased the mere gathering of facts and have turned to the determination of relations. Long years of preparation are needed to fit one to begin investigation; familiarity with several languages is demanded; great libraries are necessary for constant reference, and costly apparatus is essential even for preliminary examination. Where tens of dollars once supplied the equipment in any branch of science, hundreds, yes thousands, of dollars are required now.

Failure to appreciate the changed conditions induces neglect to render proper assistance. As matters now stand, even the wealthiest of our educational institutions cannot be expected to carry the whole burden, for endowments are insufficient to meet the too rapidly increasing demand for wider range of instruction. It is unjust to expect that men, weighted more and more by the

duties of science teaching, involving too often much physical labor, from which teachers of other subjects are happily free, should conduct investigations at their own expense and in hours devoted by others to relaxation. Even were the pecuniary cost comparatively small, to impose that would be unjust, for, with few exceptions, the results are given to the world without compensation. Scientific men are accustomed to regard patents much as regular physicians regard advertising.

America owes much to closet students as well as to educated inventors who have been trained in scientific modes of thought. The extraordinary development of our material resources—our manufacturing, mining and transporting interests—shows that the strengthening of our educational institutions on the scientific side brings actual profit to the community. But most of this strengthening is due primarily to the unremunerated toil of men dependent on the meagre salary of college instructors or government officials in subordinate positions. Their aptitude to fit others for usefulness, coming only from long training, was acquired in hours stolen from sleep or from time needed for recuperation. But the labors of such men have been so fruitful in results that we can no longer depend on the surplus energy of scientific men, unless we consent to remain stationary. If the rising generation is to make the most of our country's opportunities it must be educated by men who are not compelled to acquire aptness at the cost of vitality. The proper relation of teaching labor to investigation labor should be recognized, and investigation, rather than social, religious or political activity, should be a part of the duty assigned to college instructors.

Our universities and scientific societies ought to have endowments specifically for aid in research. The fruits of investigations due to Smithson's bequest have multiplied his estate hundreds of times over to the world's advantage. He said well that his name would be remembered long after the names and memory of the Percy and Northumberland families had passed away. Hodgson's bequest to the Smithsonian is still too recent to have borne much fruit, but men already wonder at the fruitfulness of a field supposed to be well explored. Nobel

knew how to supply the results of science; utilizing the chemist's results, he applied nitro-glycerine to industrial uses; similarly, he developed the petroleum industry of Russia, and, like that of our American petroleum manufacturers, his influence was felt in many other industries of his own land and of the Continent. At his death he bequeathed millions of dollars to the Swedish Academy of Science, that the income might be expended in encouraging pure research. Smithson, Hodgson and Nobel have marked out a path which should be crowded with Americans.

The endowment of research is demanded now as never before. The development of technical education, the intellectual training of men to fit them for positions formerly held by mere tyros, has changed the material conditions in America. The surveyor has disappeared; none but a civil engineer is trusted to lay out even town lots; the founder at an iron furnace is no longer merely a graduate of the casting-house—he must be a graduate in metallurgy; the manufacturer of paints cannot entrust his factory to any but a chemist of recognized standing; no graduate from the pick is placed in charge of mines—a mining engineer alone can gain confidence; and so everywhere. With the will to utilize the results of science there has come an intensity of competition in which victory belongs only to the best equipped. The profit awaiting successful inventors is greater than ever and the anxious readiness to supply scientific discoveries is shown by the daily records. The Roentgen rays were seized at once and efforts made to find profitable application; the properties of zirconia and other earths interested inventors as soon as they were announced; the possibility of telegraphing without wire incited inventors everywhere as soon as the principle was announced.

Nature's secrets are still unknown and the field of investigation is as broad as ever. We are only on the threshold of discovery, and the coming century will disclose wonders far beyond any yet disclosed. The atmosphere, studied by hundreds of chemists and physicists for a full century, proved for Rayleigh and Ramsay an unexplored field within this decade. We

know nothing yet. We have gathered a few large pebbles from the shore, but the mass of sands is yet to be explored.

And now the moral has been drawn. The pointing is simple. If America, which, more than other nations, has profited by science, is to retain her place Americans must encourage, even urge, research, must strengthen her scientific societies and her universities, that under the new and more complicated conditions her scientific men and her inventors may place and keep her in the front rank of nations.

New York University,
February, 1898.

[Annals N. Y. Acad. Sci., XI, No. 10, pp. 193 to 217, July 29, 1898.]

DESCRIPTION OF SOME MARINE NEMERTEANS OF PUGET SOUND AND ALASKA.

B. B. Griffin.

(Read March 14, 1898.)

Bradney Beverley Griffin died of pneumonia on March 26th—less than a fortnight after the present paper was read before the Academy. The editor of the Annals has now sent me the proof for revision and has arranged that a brief notice of his life and work should be inserted as its preface.

Mr. Griffin came rightfully by his deep interest in science, for his forefathers on both sides had been prominent in the learned professions, that of medicine especially. His father, Dr. Bradney Griffin, although dying young, was a well-known practitioner in New York. Mr. Griffin's mother is of the Hollister family: his paternal grandmother was a du Barrière, one of whom together with other nobles emigrated to this country during the French Revolution.

Mr. Griffin received his first degree in 1894, graduating with highest honors, at the College of the City of New York. He there evinced a remarkable bent for zoölogy. Continuing his studies in the graduate Department of Columbia University he would have taken the Degree of Doctor of Philosophy at the present Commencement. He had held the position of University Fellow in Zoölogy and had taken part for two years in the summer expeditions to the northwest coast.

His published writings appear, with one exception, in the Transactions of the Academy. Their results are of permanent value and have already received marked attention both in this country and abroad. His mind was mature and none of us knew before his death that he was but twenty-six. His work showed to all, as memorial notices in foreign journals testify, that he was an investigator of rare promise; but those who knew him well can alone understand how much he would have contributed to zoölogical knowledge had his life been spared. I have never known a more perfect example of sacrificing devotion to a life's work. He gave his best energy—more than his health could spare—to zoölogy for zoölogy's sake. Personally, he was retiring, asked for nothing and cared for nothing in the way of material advancement. His industry was incessant, and was rarely directed in vain; he was conscientious even to the least of things; he made it clear to us that his ideals were the highest and that he did as he believed.

BASHFORD DEAN.

COLUMBIA UNIVERSITY, July 12, 1898.

PUBLISHED WRITINGS BY MR. GRIFFIN.

'96. The History of the Achromatic Structures in the maturation and fertilization of Thalassema. *Trans. N. Y. Acad. Sci.*, Vol. XV, pp. 163–176, pls. IX–XI.

'97 (1) A brief account of the work of collecting in Puget Sound and on the Pacific coast. (With others.) *Ibid.*, Vol. XVI, pp. 33–43, pl. I.

(2) Notes on the distribution and habits of some Puget Sound Invertebrates. (With N. R. Harrington.) *Ibid.*, pp. 152–165.

(3) Adaptation of the shell of Placuanomia to that of Saxidomus, with remarks on shell adaptation in general. *Ibid.*, pp. 77–99.

'98 (1) Description of some marine Nemerteans of Puget Sound and Alaska. (The present paper.)

(2) The Maturation and Fertilization of Thalassema. A thesis for the degree of Doctor of Philosophy. *Journal of Morphology.* (Shortly to appear.)

I. INTRODUCTION.

The forms here described were collected by the writer while a member of the Columbia University expeditions of 1896 and 1897 to Puget Sound and Alaska. During the first of the summers spent on the Pacific coast about 10–15 different forms were collected, all from the region about Port Townsend, Washington. The work of the second summer added about 15 Alaskan forms to the collection, besides three additional species from Puget Sound.

Upon the return the writer lost by shipwreck not only the Alaskan material, but all the previously prepared sections and much valuable literature, together with manuscripts including notes upon the color, form, habits and habitats of the living animals. The consequent necessity of replacing the literature and resectioning the entire set of forms has, as may be readily understood, greatly delayed the publication of the specific descriptions.

The collections were made with the view of accumulating material for a monograph of the Nemerteans of the Pacific coast of the United States, and it is hoped that the present brief notice will be followed by a more extensive work with colored plates. The special interest attaching to certain of the forms (*e. g.*, *Carinoma*), as well as the general importance of the formal peculiarities of heretofore unexplored regions, will, it is hoped, prove a sufficient excuse for the publication of the present paper.

The species here described do not represent the entire number collected, since, in addition to those lost by shipwreck, several have been omitted in which the material was either too poorly preserved or too scanty for adequate determination.

As regards terminology, Montgomery's term ('96) mesenchyme will be used to designate that tissue formerly known as "parenchyme," "body-parenchyme" and "gelatinous tissue." The four vascular trunks of the mesonemerteans will be distinguished as dorso-lateral and ventro-lateral vessels (=respectively "Rhynchocölomseitengefässe" and "Seitengefässe" of Bürger, "supra-proboscidian-sheath-vessels" and "blood vessel" of Oudemans).

The writer wishes to express his grateful acknowledgements to Professor H. P. Johnson, of the University of California, for his very kind assistance in obtaining southern specimens of *Emplectonema viride* Stimpson. He also feels indebted to Mr. Mutty, of Port Townsend, for his permission to use one of his buildings as a laboratory, and to Mr. Shaffer for his kind loan of collecting appliances.

II. HISTORICAL.

During the years 1857–58 there appeared in the *Proceedings* of the Philadelphia Academy a series of preliminary papers by Dr. William Stimpson, in which he briefly described the invertebrates collected upon the North Pacific Exploring Expedition (1853–56). The collections made by Dr. Stimpson include, among other groups, thirty-three species of Nemerteans, obtained at points along the coasts of North America and Asia, though principally from Japan and China.

Stimpson arranged his thirty-three species under seventeen genera, of which the following ten were new: *Diplopleura*, *Tæniosoma*, *Dichilus*, *Cephalonema*, *Emplectonema*, *Diplomma*, *Dicelis*, *Polina*, *Tatsnoskia* and *Cosmocephalia*.[1] One half of the new genera have now proved synonyms. Thus *Dichilus* and *Cosmocephalia* = *Amphiporus* (Verrill '92); *Tæniosoma* = *Eupolia* (Bürger '95 (2)); *Polina*, according to Bürger = *Eupolia*, but according to Verrill = *Amphiporus*. Those of the other half (viz. *Cephalonema*, *Diplomma*, *Dicelis* and *Tatsnoskia*) have not, to the knowledge of the present writer, been identified with any of the valid genera of the present day. Their fate must await further work upon these Japanese and Chinese forms. Of the remaining seven genera, four (*Lineus*, *Cerebratulus*, *Valencinia* and *Tetrastemina*) were well recognized at the time Stimpson wrote, and are still valid; while three (*Meckelia*, *Polystemma* and *Serpentaria*) are synonyms of *Cerebratulus*, *Amphiporus* and *Cerebratulus* respectively.

Two of the ten new generic terms invented by Stimpson rep-

[1] His classification throughout is superficial and based in the main upon trivial external characters.

resent valid genera, and, as Verrill ('95) has urged, should, by virtue of priority, supersede those now generally accepted by European writers. *Emplectonema* is sufficiently well defined, so that "Sicher ergiebt sich trotz der unvollkommenen Diagnosen dass 49 und 55 mit *Eupolia* und 52 (*Emplectonema*) mit *Eunemertes* zusammenfallen." (Bürger '952). As *Emplectonema* long antedates *Eunemertes* (Vailant '90), it should stand for this genus. Similarly *Diplopleura* is at once recognized as identical with *Langia* (Hubrecht '79) and has priority.

Owing to loss of plates and material in the great Chicago fire, Stimpson was unable to publish his detailed descriptions and colored drawings. The *Prodromus*, accordingly, together with a brief paper on Chinese and Japanese forms (1855), represents, to the knowledge of the present writer, all the published work upon North Pacific Nemerteans up to date.

Of the species obtained by the present writer, one (*Emplectonema viride* Stimpson) was described in the *Prodromus*; the other (*Emplectonema violaceum* Bürger) was described by Bürger ('96) from the Chilian Coast, while the remainder do not seem to have been noticed by either. Among the latter is one form of special interest in that its genus, which represents a transitional type, has heretofore been represented by two species only, both of which are very rare. This form *which occurs abundantly* in the Puget Sound region, is a new species of *Carinoma*. In order, however, to make clear the relationships and significance of *Carinoma*, it will be necessary to briefly trace the historical development of Nemertean taxonomy.

One of the most servicable taxonomic systems was that proposed by Max Schultze in 1852, which divided the Nemerteans into the well-known ENOPLA and ANOPLA, based upon the respective presence or absence of calcareous stylets in the proboscis. Although this system was generally accepted and adopted in the older text-books, it finally became evident that the mere presence or absence of stylets is no *certain* indication of affinity. Thus forms are known whose inner organization in other respects conforms to the Enoplous type, yet lack the stylets (*e. g.*, *Malacobdella*, *Pelagonemertes*). Moreover, the Anopla

proved a very heterogeneous assemblage, since under this term forms were included that differ as widely from each other as they do from the Enopla (*e. g.*, *Carinella*, *Cephalothrix*, *Cerebratulus*). These faults were partially removed by Hubrecht ('79) in the following system :

1. PALÆONEMERTINI.

No deep lateral fissure on the side of the head. No stylet in the proboscis. Mouth behind ganglia.

Carinella, *Cephalothrix*,
Polia, *Valencinia*.

2. SCHIZONEMERTINI.

A deep longitudinal lateral fissure on each side of the head, from the bottom of which a ciliated duct leads into the posterior lobe of the ganglion. Lateral nerves between the longitudinal and inner circular muscular coat of the body wall. Nervous tissue deeply tinged with hæmoglobin. Mouth behind the ganglia.

Lineus, *Borlasia*,
Cerebratulus, *Langia*.

3. HOPLONEMERTINI.

One or more stylets in the proboscis. Mouth generally situated before the ganglia. Lateral nerves inside the muscular coats of the body-wall. No deep longitudinal fissures on each side of the head.

Drepanophorus, *Amphiporus*,
Tetrastemma, *Prosorhochmus*,
Oerstedia, *Nemertes*.

The above system, the result of a deeper study of the inner organization of these worms, marked an important advance in taxonomy. A single character (presence or absence of stylets) is here no longer taken as the basis of division, but a group of characters ; and, moreover, the importance of the number and

position of the muscular coats of the body-wall in relation to the nerve cords commences for the first time to be recognized.

But excellent and serviceable as the Hubrechtian system was, it still possessed a defect which became more conspicuous with increase of our knowledge of the comparative anatomy and embryology. It still associated under the term PALÆONEMERTINI such forms as *Carinella*, *Cephalothrix* and *Polia* (= *Eupolia* Hubrecht '87), the last named type being more closely related to the SCHIZONEMERTINI than to *Carinella*. The following sentence from Oudemans ('85) shows how quickly this defect became obvious with careful comparative study. "Though the families of the *Valenciniidæ* and the *Poliidæ* belong to the PALÆONEMERTEA, they, with respect to their vascular and nephridial system, already approach the SCHIZONEMERTEA. To avoid confusion, I will here employ the expression, "Palæo-type," "Schizo-type" and "Hoplo-type." Bürger ('90) went even further, and, after a severe criticism of Hubrecht's system, proposed a return to the Anopla and Enopla of Max Schultze. During the next two years, however, Bürger ('91 and '92) elaborated and published a new system, which of all those heretofore proposed seems to come the nearest to expressing the true interrelationship of the main groups of Nemerteans.

Before taking up Bürger's system in detail we must glance briefly at the phylogenetic theories as influenced by the discovery of *Carinoma*. All are agreed that the epithelial position of the nerves in *Carinella* is a primitive feature. Accordingly the derivation of the remaining Nemertean orders from *Carinella*-like ancestors involves an inward migration of the nerve-cords. Even before the discovery of *Carinoma* a fairly complete series could be arranged from *Carinella* with its epithelial nervous system, through *Cephalothrix* with nerve-cords in the longitudinal layer, to *Cerebratulus* in which the nerve-cords have apparently migrated further inward to lie closely appressed (and sometimes indenting) the inner circular muscle layer, leading finally to the Enoplous types with the nerves internal to *all* the muscular coats. (Compare figures in Hubrecht '87.)

In 1875 McIntosh obtained at Southport, England, a spe-

cies which he described as *Valencinia armandi* n. sp. The careful description of this form by its discoverer (MacIntosh '75) and the able anatomical investigations of Oudemans ('85) made it clear that *Valencinia armandi* is not only the representative of a distinct type (allied to *Cephalothrix*), but a form in many respects intermediate between *Carinella* and other Nemerteans. The special interest centers in the fact that anteriorly the nerve-cords lie in a similar position to those of *Carinella* (although surrounded by a thin layer of longitudinal muscles), while more posteriorly they break through the outer circular layer and lie for the rest of their course within the longitudinal layer. Oudemans was thus thoroughly justified in creating the new genus *Carinoma* for its reception. For twenty years the form remained the sole representative of its genus. In 1895 Bürger described the *C. patagonica* from some very scanty material collected at Punta Arenas, Patagonia. Of this material he observes: "Über ihr Aussehen im Leben fehlen leider Angaben." In *C. patagonica* the nerves lie wholly within the longitudinal muscle layer, so that within the limits of the genus *Carinoma* we have accomplished the theoretically required migration of the nerves through the circular muscle layer. It now became easy[1] to derive the Enopla directly from *Carinella* through *Carinoma* and *Cephalothrix*,[2] while the *Schizonemertean* type (including the Eupolidæ) comes off as an independent side branch from an ancestor of *Carinoma*, which retained the nerve-cords outside of the circular muscles, but lost the inner circular layer and developed a new longitudinal layer beneath the basal membrane of which *Carinoma armanda* shows rudiments.[3]

These points are all clearly recognized in Bürger's taxonomic system. *Carinella* with *Carinoma* and *Hubrechtia* constitute the first and most primitive order PROTONEMERTINI; *Carinoma* and *Cephalothrix* are ranked as an independent order MESONEMERTINI;

[1] Cf. Bürger '95 (2).

[2] *Carinoma*, while more primitive as regards the nerve-cords and presence of nephridia, seems to have lost the cephalic organs still retained in *Cephalothrix* (compare Joubin '90).

[3] Such an ancestor Bürger believes to be realized in *Hubrechtia desiderata* (v. Kennel).

the Enopla constitute the METANEMERTINI, while the remaining representatives of Hubrecht's *Palæonemertini* (viz., the Eupolidæ) are grouped with the *Schizonemertini* under the ordinal term HETERONEMERTINI.

Thus with the establishment of Bürger's system there appears to vanish the last vestige of artificiality in the ordinal classification, and for the first time we have a system that may be called a natural one.

III. SPECIAL DESCRIPTIONS.

PROTONEMERTINI.

1. **Carinella sexlineata** n. sp.

In form, color and internal anatomy this species very closely resembles *C. superba* (Kölliker), being marked by creamy white lines and annulations disposed upon a ground color of reddish brown. The principal difference lies in the *pattern* of the markings, which renders the form the most complicated of the genus.

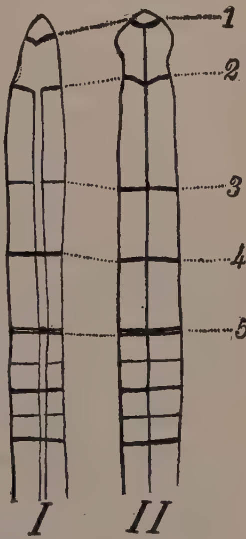

FIG. 15. *Carinella sexlineata* n. sp. I. Lateral. II. Dorsal aspect. Drawn from alcoholic specimens.

Near the anterior margin of the head and well in front of the mouth occurs transverse band 1 (Fig. 15, I), which in the type specimen consisted of a broader dorsal and narrower ventral half meeting laterally in a sharp posteriorly directed angle. From band 1 there extends a mid-dorsal line the whole length of the body. A short distance behind the neck[1] occurs band 2, which is broad and distinct, but interrupted laterally whence proceed caudad *two-paired lateral lines.* These extend the whole length of the body. A mid-ventral line also commences from band 2, arising from a flecked area involving the lower laterals.

[1] Neck = constriction separating head from rest of body.

The mouth is situated between bands 1 and 2 and in type specimen did not pierce band 2 (difference from *C. superba*). At intervals much greater than between 1 and 2 occur bands 3, 4 and 5, with no intermediate annulations. Band 3 is the broadest, its edges fimbriated, and interrupted between the laterals; 4 and 5 are more sharply outlined, 4 continuous, 5 partially interrupted at the laterals by the side organs (difference from both *C. superba* and *C. annulata*, in neither of which do the side organs occur on a transverse band). The broken mid-ventral line continues nearly to band 5, where it breaks up into a row of fine dots which may be sometimes traced along the rest of the body. From band 5 to posterior extremity of body occur broad uninterrupted annulations sometimes double, placed some distance apart, with one to three finer intervening annulations, which are interrupted or nearly so at the laterals. The intervals between these body annulations are nearly equal.

VARIATIONS. It must be noted on behalf of the validity of this species that the above outlined pattern is in its main features remarkably constant. The variations, so far as was observed, involve merely the shade of the ground color, the amount of flecking, the *composition* (*i. e.*, whether full or broken) and extension of the lines. The few specimens obtained near Sitka, Alaska, were darker in color, with much less flecking and fimbriation of the annulations. Those taken about Puget Sound showed considerable flecking on the head behind band 1 and on dorsum, mostly near lines or bands. Moreover, in some specimens the lines are more continuous, in others more or less dotted or broken.

In alcohol the worm darkens considerably, but even then the main pattern can be easily made out. The side-organs then appear as white circular spots.

INTERNAL ANATOMY. A cephalic gland is absent as in *C. superba*. Differs from latter in general absence in region of side organ of a pronounced dorsal and ventral decussation of the circular muscles of the body-wall. A fine raphé of connective tissue is generally present in its place, which may involve a few muscle-fibers. In one individual sectioned these were so abun-

dant as to produce a decussation similar to *C. superba.* The variation of this structure would appear to show that but little reliance can be placed upon it for specific determinations. A layer of longitudinal muscle fibres separates the œsophagus from the circular muscles of the rhynchocœlom as in *C. rubicunda.* Cephalic organs consist of a paired ciliated tube which penetrates the epithelium to end blindly next the basal membrane. Nephridia consist of branching tubules, portions of which bulge more or less into the lateral vessels. They open at their posterior extremity by a pore above the side organs, *i. e.*, in transverse band 5.

Habitat and Distribution. Dredged in Kilisut Harbor opposite Port Townsend, in from 3 to 4 fathoms, also taken under bark of wharf-piles in its tough hyaline tube, as well as in the sand between tides. Likewise taken in and about Sitka Harbor, Alaska.

This worm grows to a great length; some incomplete fragments when fully extended were over a meter in length.

2. **Carinella rubra** n. sp.

? *C. miniata* Hubrecht.[1]

Color in life a uniform bright red. In alcohol the pigment quickly washes out, leaving the worm a dull gray. The mature worm reaches an enormous length, some of the smaller individuals (incomplete) measuring over 140 cms., while the largest observed must have been at least two meters in length.

Internal Anatomy. Well developed glands fill the head (differences from *C. polymorpha*). Cephalic organs are epithelial pits which do not reach the basal membrane. Dorsal and ventral decussation of circular muscles absent or very weak.

Habitat and Distribution. Taken in sand and silt between tides at Puget Sound (Bremerton), Kilisut Harbor, and Sitka, Alaska.

[1] Bürger ('95) figures a red species (*C. miniata* Hubrecht) which may possibly be identical with this species, but since no sections were obtained its identity with *C. rubra* can be but a matter of conjecture. In color, size and form of head they differ not a little. In form and size *C. rubra* more nearly resembles *C. polymorpha.*

MESONEMERTINI.

3. **Carinoma mutabilis** n. sp.

Color a pure creamy or milky white, with faint cloudy mottlings in intestinal region, which cease a short distance from the posterior extremity, leaving the tail region pure white.

Length and breadth variable, the largest individuals of the type measured 14 cms. by 1 mm. in alcohol.

FIG. 16. *Carinoma mutabilis* n. sp. I. Two individuals of type. II. variety *argillina*. Camera lucida from alcoholic material.

Head hemispherical, narrower than body and marked off from latter by a slight narrowing or neck. No eyes or caudal cirrus.

INTERNAL ANATOMY. This species approaches very closely the *C. patagonica* Bürger ('95). It appears to differ, however, in several particulars, especially in size and in the disposition of the nephridial tubules. The latter are large and loosely ramified, but three or four cross sections of them appear in each section and, although some of the branches are situated close to the blood vessels, they do not appear to bulge into them to the extent that they do in *C. patagonica.* They open to the exterior by a single-paired excretory pore, the position of which varies in different varieties, though always dorsal to the nerve-cords. Circulatory system in its main features as in *C. patagonica.* Ventro-lateral blood vessels thick-walled, thickness of which steadily increases as nephridial region is reached. This peculiarity can be traced throughout the nephridial region.[1] Dorso-lateral vessels thin-walled throughout. Dorsal and ventral nerves anteriorly outside the outer circular muscle-layer. A double diagonal muscle-layer commences to appear in the anterior œsophageal region.

Inner circular-muscle-layer much thicker anteriorly than in *C. patagonica.*

[1] Compare similar phenomenon figured by McIntosh ('75).

Just in front of the nephridial region the following changes occur:

1°. Inner circular-muscle-layer becomes enormously thickened.

2°. Dorsal and ventral nerves commence to break through the outer circular-muscle-layer and dip down toward the inner layer.

3°. Lateral nerve cords commence to break away from the inner side of the outer circular-muscle-layer and sink deeper into the longitudinal layer.

4°. Diagonal muscles commence to thin out, to disappear completely a short distance further back.

Proboscis-pore subterminal, cephalic lacunæ extend to tip of head. A cephalic gland is present in type specimen. It consists of deeply staining lobules that hang into the cephalic lacunæ anterior to the proboscis pore.[1] Brain, with lacunæ and rhynchocœlom in brain region, more or less completely inclosed in an inner capsule of connective tissue separated from basal membrane by a thin longitudinal muscle-layer. Mesenchyme scanty.

Habitat and Distribution. In sand between tides and on piles of wharves, along the west shore of Port Townsend harbor, between the wharves of the city and the railroad depot.

Two varieties of this species were taken, which for convenience of reference will be distinguished by varietal names.

4. **Carinoma mutabilis argillina** n. var.

General form and color as in type. The entire worm was not obtained; the largest fragment measures 15 cms. by 3 mm. in alcohol. Differs from type in larger size, rather more powerful muscular development. Excretory pore in œsophageal region where inner circular-muscle-layer is still thick, and anterior to cessation of dorso-lateral vessels, *i. e.*, slightly further cephalad than in type. Mesenchyme rather more extensive, lateral halves meeting in mid-ventral line behind mouth.

[1] Bürger ('95(1)) makes no reference to a cephalic gland in *C. patagonica*, and ('95(2)) is not quite sure of its presence in *C. armandi*.

Habitat and Distribution. Between tides in hard blue clay among pholads, not apparently in burrows of latter, but in surrounding clay, to all appearances excavating burrows of its own.[1] Locality, west of Point Wilson on shore of Strait of Juan de Fuca.

5. **Carinoma mutabilis vasculosa** n. var.

Form and color as in type, size intermediate between type and var. *argillina*. Mesenchyme most extensive, in œsophageal region nearly surrounding the very large blood vessels. Ventro-lateral vessels branch from time to time. Excretory pore at commencement of visceral region where inner circular-muscles thin out.

Habitat and Distribution as in type, except that it was not taken on piles.

All these varieties build sand-tubes and in mode of life resemble somewhat *Cerebratulus*, though they do not swim nor readily fragment themselves as do the cerebratulids, and appear generally more sluggish.

Analytical Key to Species of Carinoma.

A.—Nerve cords anteriorly without circular muscle layer ; further back they break through the latter, and lie wholly within longitudinal layer.............................**C. armandi** (McIntosh) Oudemans.

B.—Nerve cords wholly within longitudinal layer throughout their entire course.

α—Small (3.5 cms.). Brain free in longitudinal muscles of head. Nephridia bulge far into thin-walled blood vessels. Dorsal and ventral nerves wholly within outer circular-muscles-layer throughout their entire course. ....**C. patagonica** Bürger.

β—Large (14–15 cms.). Brain enclosed in connective tissue capsule. Nephridia do not bulge so far into the thick-walled blood vessels. Dorsal and ventral nerves anteriorly without outer circular-muscle-layer ; further back break through same...**C. mutabilis** Mihi.

[1] If this be true, the fact is interesting because of the soft-bodied nature of the animal. The annelid *Halla* ? is known to bore in the till (Harrington and Griffin, '96), but this animal, unlike the Nemertean, has powerful jaws and a firm exo-skeleton. Heretofore no Nemertean has been known to bore in so hard a substance (McIntosh, '68).

METANENMERTINI.

6. **Emplectonema** Stimpson, 1857.

1873 *Nemertes* McIntosh (*nec* Cuvier 1817).
1873 *Macronemertes* Verrill.
1890 *Eunemertes* Vaillant.

This genus is defined by Stimpson as follows: "Corpus longissimum subfiliforme, depressum, proteum. Caput subdiscretum, stricturis nullis, fovea longitudinali in utroque margine antero-laterali. Ocelli plurimi." Later writers (including McIntosh, Vaillant, and Bürger) have added the following anatomical characters to the definition. Mouth opens into the rhynchodeum; proboscis very short; rhynchocœlom restricted to anterior third of body; cerebral organs very small and far in front of brain; head gland but rarely reaches to brain.

7. **Emplectonema viride** Stimpson, 1857.

Stimpson gives the following description of this species in his *Prodromus:* "Corpus depressum, lineare v. proteum, supra viride, subtis album. Caput subdiscretum, marginibus albis; foveis elongatis bipartitis; fronte emarginata. Ocellorum acervi quattuor; posteriores distincti, rotundati, ocellis confertis; anteriores marginales juxta foveas, occellis sparsis. Long. 11 lat. 0.05 poll. Hab. in portu 'San Francisco' littoralis inter lapillos."

The form here referred to *E. viride* occurs widely distributed from Puget Sound to Alaska, and shows no local variations, the same varieties being found in all localities visited. As a general rule, however, the specimens from the more northern latitudes are darker in hue.

Length of largest specimen nearly 1 m., breadth 1–2 mm., head spatulate, emarginate in front, not especially marked off from body, not wider than body.

Three color varieties are common: (1) A slender and smaller form, very light olive green, (2) a much darker green form which shows on head and anterior portion of body, a mid-

dorsal longitudinal line, and one transverse band at neck (fig. 17, (3), a form almost black and not showing the lines that characterize No. 2. All three varieties agree in the much lighter ventral portion marked off from darker dorsum by sharp line of demarcation. Anterior and lateral margins of head in all three varieties very light almost white. Eyes numerous, distributed along side of head, on each side of demarcation-line between light margin and dark dorsum. The colors keep fairly well in alcohol, darkest green, paler, palest olive, and even bluish varieties can be distinguished. Some specimens from West Berkeley, California, became gray in alcohol.

FIG. 17. *Emplectonema viride* Stimpson. Showing pattern on head.

INTERNAL ANATOMY very similar to *E. gracile*. Mouth opens into rhynchodeum; cephalic organs some distance in front of brain; canals from cephalic organs run forward to open ventrally in region of proboscis-pore; proboscis-pore[1] some distance from tip of head.

Intestinal cæca do not quite extend to brain. Central stylet of proboscis with very long basal portion, two marginal stylet-pockets are present, each containing five long curved stylets. Ducts from these marginal pockets appear to be dilatable proximally (fig. 18). In some specimens preserved in alcohol the stylet gland and basal portion of central stylet are a bluish green in color and contrast strongly with the adjoining non-pigmented portion of the proboscis.

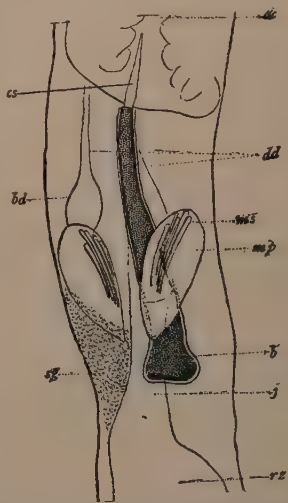

FIG. 18. *Emplectonema viride.* Stylet and region of proboscis. *ac.*—anterior chamber. *cs.*—Central stylet. *dd.*—ducts of marginal pockets. *bd.*—basal dilation of same. *ms.*—marginal stylets. *mp.*—marginal pockets. *b.*—basal portion of central stylet. *j.*—ejaculatory duct. *sg.*—stylet gland. *rz.*—reservoir.

[1] In instances like this where the mouth opens into the rhynchodeum the common opening ("gemeinschaftliche Oeffnung" Bürger) will be called proboscis-pore.

This species very strikingly resembles *E. gracile* Johnston. It may be distinguished by its narrower head with sharply defined color patterns and general darker hue of body.

HABITAT AND DISTRIBUTION. Taken on piles, on and under stones at Port Townsend, Washington; Fort Wrangle and Sitka, Alaska. The type locality (Stimpson) is the bay of San Francisco. Its range, as so far determined, is then from San Francisco to Sitka.

8. **Emplectonema violaceum** Bürger, 1896.

Eunemertes violacæ Bürger.

In life this form secretes an enormous amount of slime in which it lies coiled up in tangled knots. It was found next to impossible to straighten it out sufficiently for accurate measurement, but its length was estimated to be at least 50 cms. Broken fragments in alcohol measure over 30 cms. Shape extremely flattened, ribbon-like. Head rounded in front, directly continuous with body. Color varies somewhat, though a fairly constant pattern is presented on dorsum, which is densely flecked with purple or brown upon a pale yellowish brown ground color. Ventral portion yellowish white. Eyes numerous.

THE INTERNAL ANATOMY agrees more or less closely with Bürger's ('96) description. It "does not possess a powerfully developed head gland. The cerebral organs are very small and lie very far in front of the brain. Many small eyes are present. The œsophagus opens into the rhynchodeum." Powerfully developed integumentary glands are present throughout the body.

HABITAT AND DISTRIBUTION. On piles about Port Townsend, coiled in a tangled mass, and enveloped in its mucus. The type specimens of Bürger were obtained near Calbuco, on the coast of Chile. Its range is thus quite extensive.

The great amount and tenacity of the slime proves an obstacle to its proper preservation, as a coagulation of the slime apparently hinders the thorough penetration of the alcohol.

9. **Amphiporus imparispinosus** n. sp.

Length in alcohol, 40–45 mm. Breadth, 1–2 mm. Color, white. Head in extension hemispherical, broader than body. Eyes numerous (23 ± on each side), distributed in two elongated concentric groups along antero-lateral to lateral margin of head, not extending behind brain as in *Zygonemertes virescens* (Verrill) (fig. 19). Body widest anteriorly, tapering off to a slender posterior extremity.

Fig. 19. *Amphiporus imparispinosus* n. sp. Camera lucida, from living worm under influence of chloral hydrate and compressed under cover slip.

Internal Anatomy. Mouth opens into rhynchodeum. Cephalic gland not prominent. Cephalic commissure[1] above proboscis-pore. Cephalic organs in front of brain, dorso-lateral to ventral ganglia, opposite mouth ; the canals open ventrally just behind proboscis-pore. Nephridia commence behind brain and open to exterior by numerous efferent ducts, just dorsal to nerve-cords. Nephridia cease just behind 2d or 3d pair of gonads. Intestinal cæca extend to brain. Apparently no integumentary glands in body. Rhynchocœlom does not extend quite to posterior extremity. Central stylet as long as basal portion, latter constricted in middle (fig. 20). Three marginal-stylet-pockets, each containing two stylets.

This species is apparently to be distinguished from *A. dubius* Hubrecht, by its numerous eyes and paler color, and from *A. Greenmanni* Montgomery, by its larger size, greater number of eyes and distribution of eyes and color of body.

Habitat and Distribution. On piles and stones, Port Townsend and Sitka.

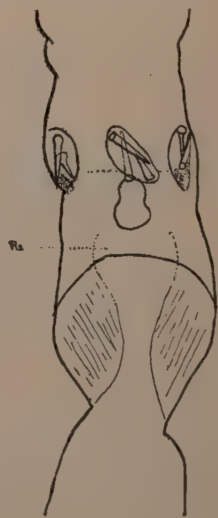

Fig. 20. *Amphiporus imparipinosus* n. sp. Stylet region of proboscis. Camera lucida from total preparation. *Rs.* reservoir.

[1] By cephalic commissure is here meant that connecting the blood vessels anteriorly.

10. Amphiporus formidabilis n. sp.

Length in alcohol 9 + cms. Breadth 2 mm. Form and color as in preceding species except for flesh-colored tinge anteriorly. Visceral region dull gray. Eyes very numerous (100–150±), distributed in three groups, one antero-lateral paired group and one median unpaired group. The latter is V-shaped and situated just in front of brain, with the limbs directed backwards and merging into two gray streaks that extend along each side for a varying distance caudad (fig. 22).

FIG. 21. *Amphiporus formidabilis.* Free-hand from living worm.

INTERNAL ANATOMY. Mouth opens into rhynchodeum. Head densely packed with cells of cephalic gland. Cephalic commissure just posterior to proboscis-pore. Cephalic organs in front of brain, opposite mouth, canals open laterally behind proboscis-pore. Intestinal cæca extend to brain. Nephridia open by numerous efferent ducts, some of which open dorsally, others laterally. Integumentary glands abundant in anterior portion of body. Rhynchocœl extends to end of body.

FIG. 22. *Amphiporus formidabilis.* Camera lucida from worm under influence of chloral hydrate under cover-slip.

Central stylet shorter than its basal portion. Marginal stylet-pockets arranged in a continuous row around the central stylet. Their number appears to be either 8 ± or 12 ±. Each contains two stylets.

In number and arrangement of the marginal stylet-pockets this form bears close resemblance to *A. spinosissimus* Bürger and *A. pugnax* Hubrecht, but differs in numerous anatomical points from *A. spinosissimus*, especially in the position of the excretory pores.

HABITAT AND DISTRIBUTION. On piles of wharves, and on stones and rocks along with *A. imparispinosus* and *Emplectonema viride.* Puget Sound and Alaska.

11. **Amphiporus brunneus** n. sp.

Length in alcohol of largest individual 3.3 cms. Breadth 5 mms. Color (in life) dark brown or smoky black on dorsum, greenish or yellowish white ventrally. On each side of neck is a pale angular spot.

FIG. 23. *Amphiporus formidabilis* n. sp. Stylet region of proboscis. The dotted pockets and stylets filled in diagrammatically, the rest from camera lucida drawing.

INTERNAL ANATOMY. Proboscis-pore subterminal. Cephalic gland moderately developed. Cephalic organ considerably in front of brain. Cephalic canals open opposite mouth. Intestinal cæca extend almost to brain. Anterior portion of proboscis very long; in ordinary protrusion the stylet-region remains within the everted anterior chamber. Basal portion of central stylet long, two marginal pockets each containing two (or three ?) stylets.[1]

HABITAT AND DISTRIBUTION. On piles and rocks about Port Townsend.

12. **Amphiporus angulatus** (Fabr.) Verrill ?

I have provisionally referred to this species a form that occurs (though not very abundantly) under stones near lowest low water mark in Sitka Harbor, Alaska. But two alcoholic specimens are now available for description.[2] It readily contracts into a thick oblong mass.

FIG. 24. *Amphiporus brunneus.* Central stylet. Camera lucida.

[1] Rhynchocœl surrounded by a thin circular muscle sheath, within which is a layer of longitudinal muscles.

[2] Owing to these two specimens having been collected too late to be packed with the rest of the Alaska material, they were placed in the writer's microscope case, and were therefore saved when the ship went down.

Length in alcohol, 4–7 cms. Breadth, 5–6 mms. Color (in life) a reddish purple on dorsum, white ventrally. Head with prominent marginal white spots at neck.

INTERNAL ANATOMY. Cephalic gland fairly well developed; proboscis-pore sub-terminal and anterior to cephalic commissure. Cephalic canals enter ventrally and run caudad for some distance in the epithelium. In the region of the mouth they break through the circular muscles to reach the cephalic organs.[1]

Cephalic organs large, considerably in front of brain. Mouth opens into rhynchodeum. Dorsal commissure fairly large. Intestinal cæca short, do not extend near to brain. Anteriorly the integumentary glands are very abundant ventrally, sparsely distributed dorsally. Rhynchocœl surrounded by thin sheath of outer circular and inner longitudinal muscles. In visceral region gonidial pockets are numerous; a single section shows several, distributed dorsally and laterally to the intestine.

HABITAT AND DISTRIBUTION. Under stones near lowest low water mark. Sitka Harbor and Redout Bay, Alaska.

Besides *A. brunneus* there are several other forms that bear a more or less general resemblance to *A. angulatus*, and are to be classed among the boreal species. Stimpson's *Cosmocephala Beringianus* and *C. Japonicus* are both believed by Verrill ('92) to be varieties of *A. angulatus*. At Sitka the present writer obtained three quite similar forms (sizes quite different) which seem to approach *A. angulatus*. When studied under a lens they were seen to possess two paired white lines between which, in two of the forms, the cervical white patches were situated, so characteristic of *A. angulatus*. In the third these angular patches seem to have been absent or represented by a faint paling of the ground color. Each of the three, with *A. angulatus* seemed to characterize a particular zone of the beach between high and low water mark.

[1] The one specimen sectioned showed an interesting abnormality in the cephalic canal and organ of one side (left?). On this side the cephalic organ lay much further caudad so as to be opposite to the ventral commissure, while its canal forked in the epithelium, one branch opening dorsally, the other more ventrally. The cephalic organ of the right side lay considerably in front of brain.

13. **Amphiporus drepanophoroides** n. sp.

Color red above, white below. Length probably not over 4–5 cms. Form short and stout. Eyes numerous in rows along antero-lateral margin of head.

Internal Anatomy. Proboscis-pore terminal. Cephalic gland prominent. Integumentary glands also prominent in head, all situated ventrally and ventro-laterally. Further back they commence to thin out (at first in the mid-ventral line) and disappear completely a short distance behind brain. Mouth opens into rhynchodeum. Cephalic organs large, anterior portion opposite ventral commissure, closely pressed against brain, further back they become pushed in between dorsal and ventral ganglia and extend back of dorsal ganglia. Their canals open laterally in front of ventral commissure. Differs from all the preceding Amphiporids in the smallness of the rhynchocœl, and in having the latter enclosed in a thick muscular sheath in which longitudinal and circular muscles are interwoven. No forwardly extending intestinal cæca. Circular muscle-layer quite thick.

Heteronemertini.

14. **Lineus striatus** n. sp.

Owing to loss of all color notes and drawings by shipwreck, no *detailed* description can be here given of its appearance during life.

Color brownish red on dorsum, sharply marked off laterally from the much lighter ventral portion. Dorsum marked by numerous creamy white transverse bands which cease at the demarkation-line between the dorsal and ventral coloring. Tip of head brilliant red. Length probably not over 4 cms.

This form seems from the above quite similar to *Micrura fasciolata*, yet it is at most but one-half the size of the latter, much flatter, the pattern much sharper and constant, and in all specimens obtained no cirrus was present. For these reasons it must at present be referred to *Lineus*.

INTERNAL ANATOMY. Nephridial system with numerous efferent ducts opening dorsally to the nerve cords. In one section two ducts occurred, one slightly dorsal to the other.

HABITAT AND DISTRIBUTION. Under stones and in sand between tides, Kilisut Harbor, and Bremerton. Not taken in Alaska.

15. **Lineus** sp. —.

This species, which appears to be new, was found among a mass of hydroids that had been preserved in formalin. The single specimen measured 5.2 cms. by 5 mms.; it was an entire worm. Color smoky black with greenish tinge on dorsum, gray-brown ventrally.

INTERNAL ANATOMY. Cutis richly supplied with gland cells of which two kinds occur, one staining with hæmatoxylin, the other with congo-red. In this respect the cutis is similar to the epithelium.

HABITAT AND DISTRIBUTION. Among hydroids (*Diphasia*) about Port Townsend.

16. **Cerebratulus marginatus** Renier.

I have referred to this species a smoky black form that occurs abundantly in the sand between tides at Port Townsend and Bremerton. Most of the specimens differed from the Neapolitan form figured in Bürger's monograph, in lacking the white coloration on the posterior extremity, and the white rims to the cephalic furrows. As the specimens showed variation in this regard, some approaching quite closely the typical form, and as the internal anatomy is indistinguishable from that of specimens from Naples, I have referred this form to *C. marginatus.*

17. **Cerebratulus** sp.

Portions of a very large dark form with flesh-colored lateral margins were obtained. Some of the fragments in alcohol measure nearly 20 mms. in diameter. In internal anatomy it seems to approach *C. marginatus;* the only noticeable point of difference appears to be that the cephalic slits cease at least

10 sections (each cut at least 30 μ thick) in front of mouth. In *C. marginatus* they cease in the section in which the mouth commences.

IV. SUMMARY.

Of the fourteen species treated in the foregoing ; nine appear to be new and peculiar to the Pacific coast of North America ; two (*Emplectonema viride* and *E. violaceum*) are already described, although likewise peculiar to the west American coast ; one (*Amphiporus angulatus*) with three problematical forms are boreal and are represented on the north Atlantic coast, and one (*Cerebratulus marginatus*) is cosmopolitan. Among the forms peculiar to the west coast are a few that show remarkably close resemblance to west European forms. Thus *Carinella sexlineata* is the Pacific representative of *C. superba*, while *C. rubra* resembles *C. miniata*. *Emplectonema viride* is very closely similar to *E. gracile*. *Lineus striata* resembles *Micrura fasciolata*.[1] Another conspicuous fact is the complete absence of Atlantic American species, outside of the strictly boreal forms such as *Amphiporus angulatus*. No banded Carinellas occur on the east coast[2], no *Carinoma* has as yet been found. The east coast Amphiporids and Lineids are either unrepresented on the Pacific or replaced by different species. The noticeable scarcity of *Lineus* on the west coast is perhaps to be correlated with the superabundance of different forms of *Amphiporus*, which apparently replace them functionally.

Zoölogical Laboratory of Columbia University,
March, 1898.

[1] If it can ever be shown that *L. striata* actually does possess the cirrus, and hence is a micruran, this parallel will be further strengthened.

[2] Except the "large Canadian *Carinella* dredged in the Gulf of St. Lawrence by Mr. Whiteaves." McIntosh '75.

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[ANNALS N. Y. ACAD. SCI., XI, No. 11, pp. 219 to 223, August 13, 1898.]

AN IMPORTANT INSTANCE OF INSECT COALESCENCE.

HENRY E. CRAMPTON, JR.

(Read March 14, 1898.)

DURING the winter of 1896–97 the writer performed a number of experiments upon lepidopterous pupæ, in order to ascertain if it were possible to produce a coalescence between two individuals, or parts of individuals, similar to that obtained by Born with the embryos of Amphibia. A report upon the results of these experiments is embodied in the form of a Woods Holl lecture for 1897. Without going into details, it might be stated that the two main problems were: first, whether "grafting," or the production of coalescence, were possible with lepidoptera; and second, if such coalescence could be brought about, whether the colors of one moth could be made to replace those of another by a transfusion of hæmolymph. The first point was determined successfully in about twenty cases out of nearly two hundred experiments. The second point remained undetermined on account of the small number of successful cases. During the present winter, in the course of a further series of experiments, numbering at present over 750, one specimen was obtained which exhibited conditions of exceptional interest. It is considered worthy of a special notice, as the full account of the winter's experiments cannot of necessity be published for some time.

The case in question (No. 341) consists of a *Callosamia promethea*, united "in tandem" anteriorly to a *Samia cecropia*. In an operation of this kind part of the abdomen of the anterior component is cut away by a transverse section back of the wing-cases, *i. e.*, between the fourth and fifth abdominal segments; the remainder of the pupa is united to a posterior com-

ponent which has been deprived by a transverse section of its anterior part, namely, head, prothorax and the basal parts of the limb, mouth-part and antenna sacs. The method of keeping the parts together, by means of melted paraffine applied to the edge of the common wound, has already been described in a communication before this section of the Academy at a meeting last spring. The condition of the pupæ was quite advanced, owing to their being kept in the warm laboratory from the time they were procured in November. But, as is often the case, one of them, the *cecropia*, was more advanced than the other, and was, indeed, ready to emerge fully five days before the *promethea*. Only the posterior portion of the pupal case of the former was removed to permit of the voidance of excreta. When the *promethea* was ready to emerge its pupal case and the remainder of that of the *cecropia* were removed. The compound was supported below a ball of cotton, so that the moths could hang suspended from it, and thus assume the attitude which is almost indispensable for the expansion of the wings. Nevertheless, in spite of all arrangements, the wings of neither component expanded, and the colors, therefore, appear on a reduced scale. The wings of the *cecropia* remained soft and evidently in a diseased discolored condition, owing, no doubt, to the prolonged enforced stay in the pupal cases.

The general appearance of the complex is that of a long body, provided with two sets of wings and legs. The facts of special interest are: first, those of the structural conditions; and second, those relating to the coloration; for, although the *cecropia* wings show no abnormalities aside from their general decomposed condition, the wings of the *promethea* exhibit some most remarkable appearances.

First, the structural peculiarities will be noted. These occur naturally at the region of union between the two components. From the *cecropia* were cut away the head, prothorax and mesothorax in part, and as well the basal parts of the antenna and palp sacs, and those of the first pair of legs. These parts are all absent in the metamorphosed complex. In dorsal view the fourth abdominal segment of the *promethea* is united to the

remains of the mesothorax of the *cecropia* by a sheet of regenerated tissue which is exactly similar to the hairless bands connecting normal abdominal segments. On the ventral side a more complicated condition appears. There is, of course, the sheet of regenerated tissue which unites the fourth abdominal segment of the *promethea* to the thorax of the *cecropia*. To this sheet of tissue are attached the bases of the coxæ of the first pair of legs, and the femoro-tibial joint of the right one as well. The second and third pairs of legs and the wings arise normally in their proper places. The antennæ and palps are absent in this specimen owing to the application of paraffine over the sacs, thus blocking them off.

It is obvious that this condition has been brought about as follows: the growing edges of the opened leg-sacs, in regeneration naturally grew fast to whatever tissue extended over them. This tissue was the regenerated band connecting the bodies of the two components. Development proceeded normally, each part completing itself as usual, and presenting in the freed complex the above condition. The reason why the knee of one limb is also fused is evident when we consider the doubled-up nature of the leg-sac. The knee had been involved in the slightly oblique section.

The color-conditions are by far the most interesting. The *cecropia*, as far as can be determined, possesses the normal specific colors. Portions of the *promethea* wings, however, *present the colors characteristic of only the wings of cecropia.*

The *promethea*, it will be remembered, was a female. In addition to the pupal diagnostic character—the relatively smaller size of the antennæ—the imago was cut open, and eggs were taken from the body, so that no doubt remains as to the sex. There are but few traces in the imaginal wings of the characteristic red-brown of this sex. In detail the colors are as follows: the upper surfaces of the anterior wings are mixed, buff and slate. Upon magnification, the scales are seen to contain only these pigments. There are few containing the characteristic reds and browns of a typical *promethea* wing. There is about the center of the wing a patch of bright red scales similar

in every way to the patches upon a *cecropia* wing, and differing from anything normal upon a *promethea* wing. The upper surfaces of the posterior wings show also the mixed slate and buff colors. There are no reds or browns, and there is no inner red line to the dark border of the wing. Below, the anterior wings have the anterior portion reddish, the middle part blackish, and posterior part red, thus differing not markedly from the normal. The posterior wings below are reddish, although with a mixture of buff quite similar to the corresponding normal *promethea* wing. The body hairs are a deep reddish purple, again a nearly normal color.

From these details it will be seen that while the body and the lower surfaces of the wings present a nearly normal appearance, or at least a condition within the possible limits of specific variation, nevertheless the upper surfaces of the wings present a very great departure from the normal, and resemble very closely the colors of a normal *cecropia* wing. The latter colors are apparently outside the bounds of possible variation within the species. And as the body cavity of the *cecropia* component lies in this case in open communication with the body cavity of the *promethea*, and thus to the wings, it may be inferred, I think, that the colors in the wings of the *promethea* which resemble the normal *cecropia* colors were produced by the presence and decomposition of *cecropia* hæmolymph where such colors appear in the *promethea* wings.

This experimental production of a transfusion of hæmolymph, and subsequent color-effect of one moth upon another, is a striking case in support of the conclusions arrived at by A. G. Mayer from a study of normal phenomena. To the work of Mayer, and to a lesser degree of some others, we owe our knowledge that the pigmental colors of *Lepidoptera* are produced by the chemical decomposition of the hæmolymph in the empty scale cells. In this case the relatively small amount of *promethea* hæmolymph was without any effect upon the *cecropia;* while the more abundant hæmolymph of the *cecropia* entering the body of the *promethea* produced, by its presence and disintegration, the colors of the *cecropia* in portions of the wings of the *promethea*.

The above conclusion receives considerable support, and, in point of fact, confirmation from the results of certain other experiments. In several cases, where a small part of the moth has been united to a much larger part, the former takes on, in the imago, the characteristic colors of the major part. One very striking case in point is one obtained recently. The head and prothorax, with other minor parts of a *polyphemus* pupa, having been removed, the corresponding parts of a *cecropia* were supplied. The resulting metamorphosed imago exhibits an apparently perfect insect. The hairs of the head and thorax derived from the *cecropia*, however, show no trace of the *cecropia* color, but are shiny buff, the color of the corresponding parts of a *polyphemus*. The available hæmolymph was, of course, only that of the *polyphemus* body, and therefore the colors were those characteristic of that species.

The foregoing account, reinforced by the other minor results above mentioned, goes to show, I believe, that it is possible *in some cases* to produce a definite color-effect of one moth upon another, by producing a coalescence between them, thus permitting a transfusion of hæmolymph. Why this reciprocal color-effect obtains in some cases, but not in others, now becomes the next problem to be investigated.

COLUMBIA UNIVERSITY.

[ANNALS N. Y. ACAD. SCI., XI, No. 12, pp. 225 to 258, August 13, 1898.]

THE NORTHROP COLLECTION OF CRUSTACEA FROM THE BAHAMAS.

W. M. RANKIN.

[PLATES XXIX–XXX.]

THE Crustacea collected by Professor and Mrs. Northrop in the Bahama Islands in 1890 were sent to me by Professor Osborn, with the request that I prepare a report on them. The following list is the result. Such a list is of necessity largely a mere catalogue of names, but it is hoped that it may be of service in the preparation of a more extensive fauna of the Bahamas when such a work shall be undertaken. It has been with the idea of giving a little wider interest to the list that with each species the range of distribution has been given, and also the West Indian Islands noted where the species has been found, although this latter record is no doubt incomplete. I hope at least these notes of distribution may serve as a suggestion for the fuller record of the distribution of these species among the West Indies. The synonymy I have made brief, merely citing the original author and usually a reference to the work where a complete synonymy may be found.

The letters (*a*), (*b*), etc., in many species indicate the various series of specimens in the collection as they were arranged originally or, in some cases, sorted out by me after their receipt. To these series I have fortunately been able to add some notes made by Professor Northrop when the collections were made, and recently sent me by Mrs. Northrop.

Among the sixty-seven species collected I have determined four as new species and one I have ranked as a new variety. There is also published for the first time a figure of *Stenopus lævis*. For the careful drawings of the figures I am indebted to Mr. R. Weber. I wish to express my obligations to Miss Rath-

bun, of the National Museum, for assistance in identifying a few species; and also to Dr. Ortmann, of Princeton, who has kindly assisted me in many ways and to whom this report owes much of any value it may possess.

DECAPODA.

BRACHYURA-CATOMETOPA.

Family **Ocypodidæ** Ortmann.

1. **Ocypode arenaria** (Catesby).

Cancer arenarius Catesby, History of the Carolinas, II, p. 35, 1771.

Kingsley, Proc. Acad. Nat. Sci., Phil., 1880, p. 184.

Ortmann, Zoöl. Jahrb., VII, p. 765, 1894.

(*a*) 5 ♂, 2 ♀. Near Nassau, N. P., Jan. 24, '90.

Range: South shore Long Island to Rio Janeiro.

Collected at Cuba, Jamaica, St. Thomas, New Providence.

2. **Uca platydactyla** (Milne-Edwards).

Gelasimus platydactylus Milne-Edwards, Hist. des Crustacés, II, p. 51, 1837.

G. heterocheles Kingsley, l. c., 1880, p. 137.

(*a*) 4 ♂. Under sides of stones, Dix Point, near Nassau, N. P., Feb. 4, '90.

(*b*) 8 ♂, 7 ♀.

Range: East and west coasts Central America, West Indies.

Collected at Jamaica.

3. **Uca vocator** (Herbst).

Cancer vocator Herbst. Natur. Krabben u. Krebse, III, pt. IV, 1804.

Gelasimus vocator Martens; Kingsley, l. c., 1880, p. 147.

(*a*) 1 ♂. Bahama Islands.

Range: East coast of America, west coast of Mexico, Panama, West Indies.

Collected at Bahamas, Cuba, Hayti, Jamaica.

4. **Uca stenodactyla** (M. Edwards et Lucas).

Gelasimus stenodactylus, M. Edwards et Lucas in D'Orbigny's Voyage, 1843.

Kingsley: l. c., 1880, p. 154. Ortmann: l. c., p. 760, 1894.

(*a*) 1 ♂. Common in mud on west side of Andros Island, near Red Cays, Apr. 17, '90.

Range: West Indies, Central America, East and West Coasts.

Collected at Cuba.

5. **Uca leptodactyla** (Guérin MS.).

Gelasimus leptodactylus Guérin MS. (types in Phila. Acad.).

Gelasimus stenodactylus Kingsley, Proc. Acad. Nat. Sci., Phila., p. 155 (part), 1880.

(*a*) 10 ♂, 5 ♀. Holes in sand between tides about 5–6 in. deep, very shy, near Ft. Montagu, Nassau, N. P., Jan. 28, '90.

Some of these specimens were sent to the United States National Museum, where they were identified by Miss Rathbun, and to whom I am indebted for the following note of description:

"*Uca leptodactyla* belongs to the division of the genus in which the front between the eyes is broad and the body is short, broad and subcylindrical. It is most nearly related to *U. stenodactyla*; the chief differences are as follows: In *U. stenodactyla* the body is much higher than in *leptodactyla*, being usually higher than long. The anterior margin of the carapace from the base of the eyestalk to the antero-lateral angle is much more oblique in *leptodactyla*, and the lateral margins are much more convergent posteriorly. The carapace of *leptodactyla* is, therefore, more pentagonal than that of *stenodactyla*. In *stenodactyla* the lateral margin is much dilated behind the antero-lateral tooth, which is not the case in *leptodactyla*. The inner surface of the hands differs as follows: The short ridge on the palm at the base of the dactylus is perpendicular to the base of the propodos in *leptodactyla*; while it is oblique in *stenodactyla*. In both species the tubercular ridge running obliquely upward from the lower margin makes an angular turn at the middle of the inner surfaces, and is continued until near the upper margin. In *leptodactyla*

this continuation runs parallel to the line of tubercles at the base of the dactylus; in *stenodactyla* the continuation is directed obliquely towards the line at the base of the dactylus."

Family **Gecarcinidæ** Dana.

6. **Gecarcinus ruricola** (Linnæus).

Cancer ruricola Linnæus, Sys. Nat. Ed. 10, I, p. 626, 1758.

Gecarcinus ruricola Leach. Edin. Encyc., VII, 430, 1814. Ortmann, l. c., p. 740, 1894.

(*a*) 1 ♂. Bahama Islands. (Dry.)

(*b*) 1 ♂. Nicolstown, Andros Island, March 9, '90. (Dry.)

Range: West Indies, Mexico.

Collected at Cuba, Jamaica, Hayti, Martinique.

7. **Cardisoma guanhumi** (Latreille).

Latreille, Ency. Méth., Hist. Nat. Insectes, X, 685, 1825.

Ortmann, l. c., p. 735, 1894.

(*a*) 1 ♂, 1 ♀, ♂ 1, juv. Move sluggishly, make holes in the ground by side of road under trees, Nassau, N. P., Jan. 25, '90.

Range: East and west coasts of Central America, West Africa.

Collected at Cuba, Jamaica, Hayti, St. Thomas, Barbadoes.

Family **Grapsidæ** (Dana).

8. **Leiolophus planissimus** (Herbst).

Cancer planissimus Herbst, l. c., p. 3, pl. LIX, 1804.

Miers, Ann. Mag. Nat. Hist. Ser. 5, I, 1878, p. 153.

(*a*) 3 ♂, 1 ♀. On shore, just south of Ft. Montagu, Nassau, N. P., Jan. 22, '90.

(*b*) 2 ♂ juv. Ocean side of Salt Cay, N. P., Jan. 31, '90.

Range: "Cosmopolitan, except the colder seas," Ortmann.

Collected at Jamaica.

9. **Plagusia depressa** (Fabricius).

Cancer depressus Fabricius, Entom. Sys. Suppl., p. 406, 1775.

Miers, Challenger, Brachyura, p. 272.

(*a*) 2 ♂. Salt Cay, New Providence. (Dry.)

Range: Charleston to Brazil, Mediterranean to St. Helena.

Collected at Cuba, Jamaica.

10. **Sesarma cinerea** (Say).

Sesarma ricordi Milne Edwards, Annal Sci. Nat. (3) Zool. t. 20, p. 183, 1853.

Ortmann, Carcinologische Studien, Zool. Jahrb., Bd. X, 1897.

(*a*) 1 ♀ with ova. Under side of stones, Dix. Pt., near Nassau, N. P., Feb. 4, '90.

Range: West Indies.

Collected at St. Domingo, Hayti, Jamaica, St. Thomas.

11. **Pachygrapsus transversus** (Gibbes).

Gibbes, Proc. Am. Ass. Adv. Sci., III, p. 182, 1850.

Kingsley, l. c., 1880, p. 198.

(*a*) 4 ♂ (juv.), 3 ♀ with ova. Nassau, N. P., under stones Jan., 1890.

Range: Warm and temperate waters of both hemispheres.

Collected at Cuba, Jamaica, Virgin Islands, Barbadoes.

12. **Grapsus grapsus** (Linnæus).

Cancer grapsus Linnaeus, Sys. Nat. ed. X, I, p. 630, 1758.

Smith, Trans. Conn. Ac. IV, 1880, p. 256. Ortmann, l. c., p. 703, 1894.

(*a*) 1 ♂, 2 ♀. Near Nassau, N. P., Jan., '90.

Range: Warm waters of both hemispheres.

Collected at Cuba, Jamaica, Hayti.

13. **Goniopsis cruentatus** (Latreille).

Grapsus cruentatus Latreille, Hist. Nat. des Crust. VI, p. 70, 1803.

Kingsley, l. c., 1880, p. 190. Ortmann, l. c., p. 701, 1894.
(*a*) 1 ♂. (Dry.)
(*b*) 2 ♀. On shore near Nassau, N. P., Jan. 23, '90.
Range: American and African Coasts of the Atlantic ocean.
Collected at Cuba, Jamaica, Hayti.

BRACHYURA—CYCLOMETOPA.

Family **Oziidæ** Ortmann.

14. **Eriphia gonagra** (Fabricius).

Cancer gonagra Fabricius, Sp. Ins., p. 505, 1781.
Ortmann, l. c., p. 480, 1894.
(*a*) 1 ♂. In pools on shore, Nassau, N. P., Jan. 21, '90.
(*b*) 1 ♀. Dix Pt., near Nassau, N. P., Feb. 4, '90.
(*c*) 1 ♂. Salt Cay. Ocean side, near N. P., Jan. 31, '90.
Range: Atlantic coast from Carolina to Rio Janeiro.
Collected at Bahamas, Cuba, Jamaica, Hayti, Barbadoes.

15. **Domœcia hispida** Eydoux et Souleyet.

Eydoux et Souleyet, Voy. Bonite, I, Crust., p. 235, 1842.
Ortmann, l. c., p. 478, 1894.
(*a*) 1 ♀, juv.
Range: West Indies, Florida, Cape Verde Islands, Senegal, Pacific Islands.
Collected at Cuba, Jamaica, St. Thomas, Guadaloupe.

16. **Panopeus herbstii** Milne-Edwards.

Milne-Edwards, Hist. Nat. Cr., I, p. 403, 1834.
Benedict & Rathbun, Proc. U. S. Nat. Mus., XIV, p. 358, 1891.
(*a*) 1 ♂. Nassau, N. P., Jan., 1890.
Range: Rhode Island to Brazil.
Collected at Bahamas, Jamaica, St. Thomas, Curaçao, Trinidad.

17. **Panopeus occidentalis** Saussure.

Saussure, Rev. and Mag. de Zoöl. (2), IX, p. 502, 1857.

(*a*) 1 ♀. Near Nassau, N. P., Febr., '90.

(*b*) 1 ♂. On shore near Nassau, N. P., Jan. 22, '90.

Range: Atlantic from S. C. to Brazil.

Collected at Jamaica, Old Providence, Guadaloupe, Curaçao, Trinidad.

18. **Panopeus americanus** Saussure.

Saussure, Rev. et Mag. de Zoöl. (2), IX, p. 502, 1857.

(*a*) 1 ♂, 4 ♀. Near N. P., Bahamas, Jan.–Febr., 1890.

(*b*) 1 ♂. On shore, near Nassau, N. P., Jan. 22, '90.

(*c*) 1 ♂. Nassau, N. P., Febr. 24, 1890, Dix Pt.

Range: West Indies to Brazil.

Collected at Jamaica, St. Thomas.

Family **Xanthidæ** Ortmann.

19. **Chlorodius floridianus** Gibbs.

Gibbs, l. c., p. 175, 1850.

(*a*) 1 ♀. Collected in pools and under stones, N. P., and neighboring cays.

(*b*) 1 ♂. Dix Pt., Nassau, N. P., Febr. 24, 1890.

(*c*) 1 ♂, 2 ♀. Near New Providence, Jan.–Feb., 1890.

(*a*) 1 ♂, 3 ♀. On shore near Nassau, N. P., Jan. 22, '90.

Range: Florida to Brazil.

Collected at Jamaica, St. Thomas, Barbadoes.

20. **Lophactæa lobata** (Milne-Edwards).

Cancer lobatus Milne-Edwards, Hist. Nat. Crustacés, I, p. 375, 1834.

Lophactæa lobata A. Milne-Edwards, Nouv. Arch. Mus. Hist. Nat., I, p. 249, Pl. XVI, 1865.

(*a*) 1 ♀. Quarantine station, Jan. 25, '90.

Range: West Indies, Gulf of Mexico, Bermuda.

Collected at Jamaica and the Antilles.

21. **Heteractæa ceratopa** (Stimpson).

Pilumnus ceratopus Stimpson, Ann. Lyc. Nat. Hist. N. Y., VII, p. 215, 1862.

Heteractæa ceratopus Kingsley, l. c., 1879, p. 396.

(*a*) 1 ♀. Dix Pt., Nassau, N. P., Febr. 24, 1890.

(*b*) 1 ♀. Quarantine station, N. P., Jan. 25, '90.

Range: Florida and West Indies.

Collected at Guadaloupe.

22. **Actæa acantha** (Milne-Edwards).

Cancer acanthus Milne-Edwards, Hist. Nat. Cr., I, p. 390, 1834.

Actæa acantha A. Milne-Edwards, l. c., p. 278, Pl. XVI, 1865.

(*a*) 1 ♂. Quarantine station near Nassau, N. P., Febr. 10, 1890.

Range: Florida Keys, West Indies.

Collected at Jamaica, Guadaloupe.

PORTUNINEA.

Family **Portunidæ** Ortmann.

23. **Callinectes larvatus** Ordway.

Ordway, Boston Jour. Nat. Hist., VII, p. 573, 1863.

Rathbun. The genus Callinectes, Proc. U. S. Nat. Mus., XVIII, p. 358, 1896.

(*a*) 1 ♂, 1 ♀, spur. juv. On shore, just south of Ft. Montagu, Nassau, N. P., Jan. 22, '90.

Range: Florida to Brazil, West Indies, Cape Verde Islands, Africa.

Collected at Bahamas, San Domingo, Jamaica, St. Thomas.

24. **Callinectes tumidus** Ordway.

Ordway, l. c., p. 574, 1863.

Rathbun, l. c., p. 359, 1896.

(*a*) 1 ♂. Nassau, N. P., Jan. 21, 1890, common in shoal water.

Range: Florida to Brazil, West Indies.

Collected at Jamaica, Hayti, Old Providence.

25. **Acheloüs depressifrons** Stimpson.

Amphitrite depressifrons Stimpson, Ann. Lyc. Nat. Hist. N. Y., VII, p. 58, 1862.

Acheloüs depressifrons Stimpson, ibid., p. 223.

(*a*) 1 ♀. Quarantine station, N. P., Jan. 25, '90.

Range: South Carolina to Florida, Bermuda, West Indies. Besides this specimen from New Providence, the Princeton Museum possesses one from the Virgin Islands; the only two localities reported from the West Indies.

26. **Acheloüs ordwayi** Stimpson.

Stimpson, Notes on N. Am. Crustacea, Ann. Lyc. Nat. Hist., N. Y., p. 224, 1862.

Smith, Trans. Conn. Acad., II, p. 9.

(*a*) 1 ♂. Quarantine station, N. P., Jan. 25, '90.

(*b*) 1 ♀, with ova. Dredged near Nassau, N. P., Jan. 22, '90.

Range: Florida and West Indies.

Collected at St. Thomas.

27. **Acheloüs tumidulus** Stimpson.

Stimpson, Bull. Mus. Comp. Zoöl., II, p. 149, 1870.

(*a*) 1 ♂. Dredged near Nassau, N. P., Jan. 22, '90.

Stimpson describes two specimens from the coast of Florida. The species is probably only the young of *A. ordwayi*, as it only differs from the latter (as noted by Stimpson) in the less prominent frontal spines.

MAIOIDEA..

Family **Periceridæ** Miers.

28. **Macrocœloma eutheca** (Stimpson).

Pericera eutheca Stimpson, Bull. Mus. Comp. Zoöl. II, p. 112, 1870.

Rathbun in Proc. U. S. Nat. Mus., Vol. XV, No. 901, p. 251, 1892.

(*a*) 1 ♀. Dredged near Nassau, N. P., Jan. 22, '90.

Range: Florida, West Indies.

Collected at Cuba.

29. **Microphys bicornutus** (Latreille).

Pisa bicornuta Latreille, Encyc. Méth., Hist. Nat. Insectes, X, p. 141, 1825.

Microphys bicornutus, A. Milne-Edwards, Nouv. Arch. Mus. Hist. Nat., VIII, p. 247, 1872.

Rathbun, l. c. (No. 901), p. 253.

(*a*) 2 ♂, 5 ♀. Common under rocks between tides and in pools, N. P., Jan., '90.

(*b*) 1 ♂. Quarantine station, N. P., Jan. 25, '90.

(*c*) 1 ♀. Nassau, N. P., Jan., '90.

(*d*) 1 ♂. On shore near Nassau, just south of Ft. Montagu, Jan. 22, '90.

(*e*) 1 ♀ juv. "Sea gardens," near Nassau, N. P., Febr., '90.

(*f*) 1 ♂, juv. Ocean side of Salt Cay, Febr. 6, '90.

(*g*) 1 ♂, juv. Nassau, N. P., Febr. 15, '90.

(*h*) 1 ♀ juv. Salt Cay, N. P., ocean side, Jan. 31, '90.

Range: Florida, West Indies to Brazil, Bermuda.

Collected at numerous islands of the West Indies.

30. **Othonia aculeata** (Gibbes).

Hyas aculeata Gibbes, l. c., p. 171, 1850.

Rathbun, l. c., p. 255, 1892.

(*a*) 1 ♂. On shore just south of Ft. Montagu, Nassau, N. P., Jan. 22, '90.

Range: Florida and West Indies.

Collected at Cuba, Bahamas, Jamaica, St. Thomas, Guadaloupe.

31. **Othonia lherminieri** Schramm.

Schramm, Crust. de la Guadaloupe, 20, 1867.

(*a*) 1 ♂, 2 ♀. On shore near Nassau, Jan. 22, '90.

The three specimens in the collection are broken and imperfect. I place them doubtfully in this species.

Range: Atlantic coast; S. C. to Brazil.

32. **Mithrax pilosus** Rathbun.

Rathbun, l. c., p. 262, Pl. XXXIX (No. 901), 1892.

(*a*) 1 ♂. Near New Providence, Jan., '90.

(*b*) 2 ♂ (fragmentary). Salt Cay, ocean side, New Providence, Jan. 31, '90.

Miss Rathbun's four specimens were collected in Abaco, Bahamas.

33. **Mithrax cinctimanus** (Stimpson).

Mithraculus cinctimanus Stimpson, Ann. Lyc. Nat Hist. N. Y., VII, p. 186, 1862.

Rathbun, l. c., p. 268 (No. 901), 1892.

(*a*) 1 ♀. Dix Pt., Nassau, N. P., Febr. 24, '90.

(*b*) 1 ♂. Quarantine station, N. P., Jan. 25, '90.

(*c*) 1 ♀ (broken). Near Nassau, N. P., Febr., 1890.

(*d*) 1 ♀ (juv.). Nassau, N. P., Jan. '90.

Range: Florida coast, West Indies, Gulf of Mexico.

Collected at Andros island, Jamaica, St. Thomas, Guadaloupe.

34. **Mithrax forceps** (A. Milne-Edwards).

Mithraculus forceps A. Milne-Edwards. Miss. Sci. au Mexique, pt. 5, I, p. 109, 1875.

Rathbun, l. c., p. 267 (No. 901), 1892.

(*a*) 6 ♀, mostly young. Ocean side of Salt Cay, Febr. 6, '90.

(*b*) 1 ♂ fragmentary. Nassau, N. P.

(*c*) 3 ♀. "Sea gardens," near Nassau, N. P., Febr., '90.

(*d*) 1 ♂, 2 ♀ juv.

Range: From North Carolina to Brazil and Guiana.

Collected at Nassau, Bahamas, Old Providence, St. Thomas, Curaçao.

35. **Mithrax sculptus** (Lamarck).

Maia sculpta Lamarck, Hist. Anim. sans Vert., V, p. 242, 1818.

Rathbun, l. c. (No. 901), p. 271, 1892.

(*a*) 1 ♂, 1 ♀. Quarantine station, N. P., Jan. 25, '90.

Range: Florida, West Indies to Venezuela, Surinam.

Collected at numerous localities in the West Indies.

36. **Mithrax coronatus** (Herbst).

Cancer coronatus Herbst, Natur. der Krabben u. Krebse., I, p. 184, Pl. XI, fig. 63, 1785.

Rathbun, l. c. (No. 901), p. 272, 1892.

(*a*) 1 ♂. Salt Cay, ocean side, near New Providence, Jan. 3, '90.

(*b*) 1 ♂ juv. Ocean side of Salt Cay, Febr. 6, '90.

Range: Florida, West Indies, Central America, Brazil.

Collected at Abaco, Bahamas, Jamaica, Cuba, St. Thomas, Guadaloupe.

Family **Inachidæ** Miers.

37. **Acanthonyx petiverii** Milne-Edwards.

Milne-Edwards, Hist. Nat. Crust., I, p. 343, 1834.

(*a*) 1 ♀ broken. Under rocks, between tides and in pools. Nassau, N. P., Jan., '90.

Range: West Indies to Brazil and California to Chili; Galapagos.

Collected at Cuba, Jamaica, St. Thomas, Guadaloupe, Martinique.

DROMIIDEA.

Family **Dromiidæ** Dana.

38. **Dromidia antillensis** Stimpson.

Stimpson, Notes on N. Am. Crust., Ann. Lyc. Nat. Hist. N. Y., VII, p. 71, 1859.

(*a*) 1 ♀. Nassau, N. P., Febr. 15, '90.

Range: Florida, West Indies, Brazil.

Collected at Antilles, Jamaica, St. Thomas.

HIPPIDEA.

Family **Hippidæ** Stimpson.

39. **Remipes cubensis** Saussure.

Saussure, Rev. Mag. Zoöl. (2), IX, p. 503, 1857.

Ortmann, Die geog. Verbreit. der Decap. gruppe der Hippidea, Zoöl. Jahrb., IX, p. 219, 1896.

Remipes scutellatus (Fabricius), Henderson, Chall. Anomura, p. 38, 1888.

(*a*) 19 ♀ (with ova). Beach at Nicolstown, Andros Island, Apr. 4, '90.

(*b*) 2 ♂, 9 ♀. Quarantine station near New Providence, Jan. 25, '90.

(*c*) 1 ♀. Nassau, N. P., Jan., 1890.

Range: "American and African shores of Atlantic," Ortmann (l. c. supra).

Collected at Cuba, Jamaica, St. Christophers, Barbadoes.

GALATHEIDEA.

Family **Porcellanidae** Henderson.

40. **Porcellana sayana** Leach.

Pisidia sayana Leach. Dict. d. Sci. Nat., XVIII, p. 54, 1820.

Porcellana ocellata Gibbes, l. c., p. 190, 1850.

Henderson, Challenger, Anomura, p. 109, 1888.

(*a*) 1 ♂. Came out of a shell inhabited by a large hermit crab. Nassau, N. P., Jan. 26, '90.

Range: West Indies and Southern shores of U. S.

Collected at Antilles, Jamaica, St. Thomas.

41. **Pachycheles panamensis** Faxon.

Faxon, Mem. Mus. Comp. Zoöl., XVIII, p. 75, Tab. 15, 1895.

Ortmann, Zoöl. Jahrb., X, 1897, p. 293.

(*a*) 1 ♂, 2 ♀. Ocean side of Salt Cay, Febr. 6, '90.

Size of ♂ 5½ mm. long, 5 mm. broad; of ♀ 5 mm. long, 6 mm. broad. These specimens have been kindly examined for me by Dr. Ortmann, who finds them identical with Faxon's type from Panama, and also very close to the Cape Verde *P. barbatus* A. Milne-Edwards. This is the first recorded specimen of *P. panamensis* from the West Indies.

42. **Petrolisthes armatus** (Gibbes).

Porcellana armata Gibbes, l. c., p. 190, 1850.

Petrolisthes armatus Stimpson, Ann. Lyc. Nat. Hist., N. Y., VII, p. 73, 1862.

Ortmann, Zoöl. Jahrb., X, 1897, p. 280.

(*a*) 1 ♂, 1 ♀. Ocean side of Salt Cay, Feb. 6, '90.

Ortmann (l. c. supra), gives full synonymy of this species and makes its distribution circumtropical; West Indies to Brazil, Gibraltar, California to Panama, Indo-Pacific.

Collected at Cuba, Jamaica, St. Thomas, Barbadoes.

43. **Petrolisthes tridentatus** Stimpson.

Stimpson, Ann. Lyc. Nat. Hist., N. Y., VII, p. 75, Pl. I, 1859.

(*a*) 1 ♂. Along shore, near Nassau, N. P, Feb. 20, '90.

(*b*) 2 ♂, 5 ♀. Salt Cay, N. P., ocean side, Jan. 31, '90.

(*c*) 2 ♂, 1 ♀. Under sponges, Nassau, N. P., Jan. '90.

Range: West Indies.

Collected at St. Thomas, Barbadoes.

PAGURIDEA.

Family **Cœnobitidæ** Dana.

44. **Cœnobita diogenes** (Latreille).

Milne-Edwards, Hist. Nat. Crust., II, p. 240, Pl. 22, 1837.

(*a*) 2 ♂. Nicolstown, Andros Island, March 23, '90.

(*b*) 2 ♂, 1 ♀. Nassau, N. P., Jan. 16, '90.

(*c*) 2 ♀. On beach, Quarantine station, near Nassau, N. P., 1890.

(*d*) 1 ♀, juv. In pools and under stones, New Providence and neighboring cays.

Range: Florida to Brazil, West Indies, Bermuda.

Collected at Antilles, Cuba, Jamaica, Hayti, Turks Island, St. Thomas, Barbadoes.

Family **Paguridæ.**

45. **Petrochirus granulatus** (Olivier).

Pagurus granulatus Olivier, Encyc. Méth., VIII, p. 640, 1811.
Henderson, in Challenger, Anomura, p. 58, 1888.

(*a*) 3 ♂.

(*b*) 1 ♂, 1 ♀. In shell of *Strombus gigas*, Nassau, N. P., Jan. 26, '90.

Range: West Indies, Gulf of Mexico to Brazil, Cape of Good Hope.

Collected at Antilles, Cuba, Jamaica.

The common large West Indian hermit crab.

46 (?) **Clibanarius vittatus** (Bosc.).

Pagurus vittatus Bosc. Hist. des Crust., II, p. 8, pl. XII, 1802.
Kingsley, Proc. Acad. Nat. Sci. Phil., p. 236, 1878.

(*a*) 1 ♂ imperfect. In small shell of *Strombus gigas*, beach near Nassau, N. P., Jan. '90.

(*b*) 1 (?) fragmentary. Near Nassau, N. P., Febr. 1, '90.

Range: Fort Macon to Florida, West Indies, Brazil.

I refer these imperfect specimens doubtfully to this species. The chelæ are wanting in (*a*), and (*b*) is too much broken to be of any value in the determination.

47 (?) **Clibanarius tricolor** (Gibbs).

Pagurus tricolor Gibbes, Proc. Amer. Assoc., p. 189, 1850.

(*a*) several specimens.

(*b*) 1 ♂. South side New Providence, in small shells of *Strombus gigas*.

The determination is doubtful, as the specimens are very poor and have almost entirely lost their color. They are all withdrawn into the shells of various littoral mollusks.

Family **Parapaguridæ** Smith.

48. **Parapagurus** sp.

(*a*) 2 ♀. Dredged, Jan. 22, '90, Nassau, N. P.

Length of thorax 3 and 5 mm. respectively.

I refer these imperfect, colorless specimens doubtfully to some species of *Parapagurus*.

LORICATA.

Family **Panuliridæ** Bate.

49. **Panulirus argus** (Latr.).

Palinurus argus Latr. Milne-Edwards, Hist. Nat. Crust., II, p. 300, 1837.

(*a*) 1 ♂, 1 ♀. New Providence, Jan. 27, '90. Holes in sand between tides, about 5–6 in. deep, "very shy."[1]

(*b*) 1 ♀. Nassau, N. P., Jan., 1890. (Dry.)

Range: West Indies to Brazil.

Collected at Antilles, Cuba, Jamaica.

STENOPIDEA.

Family **Stenopidæ** Bate.

50. **Stenopus hispidus** (Latreille). (Pl. xxix, Fig. 1.)

Palæmon hispidus Olivier, Encyclop., VIII, p. 666, 1811.

Stenopus hispidus Latreille, Regne animal de Cuvier, ed 2, IV, p. 93.

Bate, Challenger, Macrura, p. 211, Pl. XXX.

Herrick, The Life History of Stenopus, Nat. Acad. of Sciences, Vol. V, p. 339.

(*a*) 1 ♂. Nassau, N. P., Jan. 22, '90. In life the antennæ are carried in front, not bent back.

I note the characters of special importance in order to com-

[1] This label is marked as doubtfully belonging to this specimen.

pare this already described species of *Stenopus* with the two species following. Rostrum with a median dorsal row of 6 spines bifurcated at extremity, a lateral row of 3 or 4 spines on each side of rostrum; no ventral spines. Back of the sixth dorsal spine a double row. Rostrum does not reach to end of peduncle of inner antennæ. Carapace of thorax very rough, with firm, sharp spines which are longer on the dorsal than on the lateral regions. Abdomen thickly armed with outwardly projecting spines. Third pereiopod long, abundantly armed with spines. The propodos with six rows above and below and two on each lateral surface.

Measurements: Total length 50.5 mm., length of cephalothorax 16.5 mm., of abdomen 34 mm., of rostrum 6 mm., of telson 9.5 mm.

Unless the Eastern form should prove distinct from the West Indian, we have a widely distributed species occurring in the warm waters of both hemispheres. It has been reported from: Indian ocean (Olivier), Australia (Peron and Lesneur), Borneo and Philippines (Adams and White), South Pacific (Dana), Amboina (DeMan), Fiji Islands and Bermuda (Bate), Cuba (Von Martens), Bahama Islands (Herrick).

I introduce a figure of this specimen (Pl. xxix, Fig. 1), although not a new species, in order to compare it with the two following species, figures of which have not yet appeared.

51. **Stenopus semilævis** Von Martens (Pl. xxix, Fig. 2).

Von Martens, Ueber Cubanische Crustaceen, Arch. f. Naturgesch., Bd. 38, p. 144, 1872.

(*a*) 1 ♂, 1 ♀ with ova. Under large sponge. New Providence, Jan., '90.

My specimens correspond very closely, except in certain minor particulars noted below, with the description given by Von Martens of a species "probably from the West Indies," which he found undescribed in the Berlin Museum and which he called *S. semilævis.*

Von Martens' description (l. c., supra) I reproduce: "Cephalothorax spiny; abdomen smooth; rostrum short, not longer

than the peduncle of the inner antennæ, compressed laterally and prolonged as a ridge nearly to the sharply marked cervical furrow, above with four teeth, below teeth wanting. Carpus of third pair of pereiopods quadrangular as in *S. hispidus*, but the chelæ compressed, with smooth sides and not so long; chelæ, including the dactyl, twice as long as broad; the upper margin sharper than the under and smooth, the under serrated. The dactyl half as long as the palma; the back of the dactyl keeled, serrated. Length from tip of rostrum to tip of telson 12 mm. Length of third pereiopod 13 mm. Breadth of chela 3 mm. The fourth pereiopod shorter than third."

I note the following peculiarities in my specimens: *Dorsal surface of rostrum with six teeth;* the fourth and sixth have each a minute subsidiary tooth. *Ventral surface with a single, not very prominent tooth.* Both margins of the chelæ of the third pereiopods very finely serrated, a rather prominent keel on the upper margin. The third pereiopod of the right and left sides similar. Telson spiny. The large specimen (♀) is 15 mm. long, the ♂ slightly smaller. Length of chelæ in ♀, 6 mm., breadth, 2.5 mm.

Not having the opportunity of comparing the Bahama specimens with Von Martens' type I prefer to consider these slight variations as possibly due to imperfect description, and to place my specimens, provisionally, at least, with Von Martens' species.

S. semilævis differs from *S. hispidus* mainly in the teeth of rostrum, the shorter rostrum, the proportionately shorter and thicker hand, the less spiny carapace of cephalo-thorax and the smooth abdomen.

52. **Stenopus scutellatus** n. sp. (Pl. xxix, Fig. 3).

(*a*) 1 (?) ♂. Under coral, near low water, Silver Cay, N. P.

Total length from tip of rostrum to tip of thorax 18 mm. Length of rostrum 3 mm., of cephalo-thorax 7 mm.

Rostrum has a single row of ten spines on median dorsal line; back of the tenth a double row of three spines extend to the cervical furrow. On median ventral line of rostrum are six spines; *no lateral spines* on rostrum. Rostrum longer than in

S. hispidus, extending beyond the peduncle of inner antennæ. Whole surface of carapace covered with delicate spines obscurely arranged in rows; usually curved forward, with a somewhat reflexed tip. Spines on dorsal surface of first two abdominal segments short and straight in a double row pointing forwards; on third segment several rows, stouter, pointing outwards; on the fourth, fifth and sixth segments spines are longer, pointing backwards. In the middle of the posterior portion of the tergum of the third abdominal segment there is a polished, slightly elevated, shield-shaped area, with crenulated margins, about 1 mm. in length. The median tergal region of fourth segment is smooth and polished, surrounded by a row of appressed spines, the same being true to a less extent of the fifth segment. I have taken the specific name from this peculiar scutellar area on the third abdominal segment. This feature seems to correspond to a triangular but less prominent area on the similar segment in *S. hispidus* which is prolonged into a smooth dorsal ridge on the next segment.

Telson lance-shaped, with a double row of spines between which is a longitudinal groove about as long as the uropodal lamellæ, which are finely serrated on their margins, and, as the telson, fringed with stiff hairs.

Eyes on short peduncles which are armed above with three short spines projecting over the cornea, and with a few spines at the anterior margin. Cornea (in alcoholic specimen) bluish-black. Inner antennæ; peduncle with a few weak spines at distal end of segments. Outer antennæ; peduncles with strong, forwardly projecting spines. Scale lined on inner margin with long, closely set hairs and prolonged into a ciliated bristle. Flagella more than twice the length of body. Third maxillipedes when extended reach a little further than extremity of rostrum; the three distal segments about equal in length.

First pair pereiopods wanting in my specimen. Second pair slender, chelate, segments of equal length. Third pair of similar proportions to those in *S. hispidus;* chelæ 7 mm. long; propodos laterally compressed and somewhat triangular in cross section, broad above; on the dorsal margin a double row of

eleven spines each, on the ventral margin a single row of nine spines; two or three rows of minute spines on lateral surfaces. A number of long, soft hairs over the fingers, especially at the tips. Hands of the two chelapods similar in size. Carpus and ischium together about equal to propodos, each armed with rows of spines. Fourth pair long and slender; dactylus bifid; propodos slightly spiny, one-half length of carpus. Carpus and propodos obscurely articulated. Fifth pair pereiopods undeveloped. Pleopods biramous, except first, with two or three spines each on the protopodite.

From the single specimen at my disposal I would compare this species with *S. hispidus* as follows: Rostrum proportionately longer (nearly ½ length of cephalothorax, in *n. sp.* (⅓ in *hispidus*), longer than peduncle of inner antennæ. Six ventral teeth (*hispidus* none), no lateral teeth, single dorsal row of ten teeth (*hispidus* six). Flagella of outer antennæ fully twice the length of body; proportion 2:1 for *n. sp.*, 7:5 for *hispidus*. Tergum of third abdominal segment with shield-shaped area. Third maxillipedes proportionately shorter than in *hispidus*. Spines on cephalothorax equally long, but less rigid than in *hispidus*, giving in general a less thorny character to the new species.

EUCIPHIDEA.

Family **Palæmonidæ** Bate.

53. **Palæmon savignyi** (Bate).

Brachycarpus savignyi Bate, Challenger, Macrura, p. 795, Pl. 129, 1888.

Ortmann, Zoöl. Jahrb., Bd. V, p. 727.

(*a*) 1 specimen. Near Nassau, N. P., Febr., '90.

(*b*) 1 specimen. Nassau, N. P., 1890.

(*c*) 5 ♀ with ova. Nassau, N. P., 1890.

Bate's specimen was from Bermuda, "in shallow water."

"This is the most northern limit of genus Palæmon," Ortmann.

The species has not been described from any other localities.

54. **Leander northropi** n. sp. (Pl. xxx, Fig. 4).

(*a*) 1 specimen. Nassau, N. P., Jan., 1890.

A single specimen with a total length of 30 mm. Length of cephalothorax to tip of rostrum 11.5 mm.

Cephalothorax with small tooth below orbit and a very minute tooth below this and a little back from the anterior margin *on the lateral surface.*

Length of rostrum to posterior end of orbit 7 mm., slightly curved upwards toward apex. *Ten* teeth above, *four* below; the first dorsal tooth forms with the tip of rostrum a bifid extremity. A long interval between first and second tooth; interval between second and third one-third the length of that between first and second; fourth, fifth and sixth teeth follow at slightly diminishing intervals, the sixth being over the posterior part of orbit of eye. *Seventh, eighth and ninth teeth close together, posterior to orbit of eye.*

The first ventral tooth is a little in front of second dorsal, second ventral below second dorsal; third and fourth at equal intervals between second ventral and orbit of eye.

Inner antennæ: Peduncle reaches beyond second ventral tooth of rostrum; proximal segment about equal to the two distal. Upper flagellum bifid; united proximal portion of 14 segments; the shorter branch has 12 segments; united therefore for *more than half its length.* The longer branch reaches beyond the undivided flagellum.

Outer antennæ: Scaphocerite with lamellar portion slightly longer than spinose, reaches beyond first ventral tooth of rostrum; flagellum exceeds the length of the body.

Third pair maxillipedes reach to end of peduncle of inner antennæ.

First and second pereiopods: Long, slender and chelate; second longer than first; chela in second as long as carpus. Third and fourth pereiopods terminate in claws.

Pleopods, biramous, setose. Telson, lanceolate, 4 mm. long, noticeably shorter than uropods, distal extremity with two sharp spines. Outer uropod imperfectly divided transversely, the proximal division ending in a lateral spine.

This species is allied to *L. petitinga* F. Müller, from Brazil (see Ortmann, Revista do Museu Paulista, II, p. 191, 1897) and to *L. maculatus* Thallwitz (Abh. Mus. Dresd., III, p. 19, 1891) from West Africa.

I am indebted to Dr. Ortmann for the preparation of the following table, which exhibits the relationship:

	L. maculatus.	**L. northropi.**	**L. petitinga.**
Inner antennæ	12–13 segments united 8 segments free.	14 segments united 12 segments free.	9 segments united 20 segments free.
Teeth of rostrum	$\frac{6+1}{3}$ 1 posterior to orbit.	$\frac{9+1}{4}$ 4 posterior to orbit.	$\frac{6+1}{5-6}$ 1 posterior to orbit.

Family **Hippolytidæ** Ortmann.

55. **Tozeuma carolinense** Kingsley.

Kingsley: Proc. Acad. Nat. Sci. Phila., p. 90, 1878.

(*a*) 1 ♀. with ova. Dredged in about 16 ft. Near Quarantine station, Jan. '90.

Kingsley's specimens are from Fort Macon and Beaufort, N. C., and Charlotte Harbor, Fla.

Measurements of Bahama specimen: total length 41 mm., rostrum 12 mm., cephalothorax (without rostrum) 7 mm., abdomen 22 mm.

Family **Alpheidæ** Bate.

56. **Alpheus edwardsii** (Audouin).

Athanas edwardsii Audouin; Planches de la descrip. de l'Egypte par M. Savigny, Crust., Pl. X, fig. 10, 1810.

Bate, Challenger, Macrura, p. 542, 1888.

(*a*) 4 specimens. Near Nassau, N. P., along shore, Febr. 20, '90.

(*b*) 1 specimen. Nassau, N. P., Jan., '90.

(*c*) 3 specimens. Under coral and in pools between tides, New Providence.

(*d*) 1 specimen. Under coral and in pools between tides, Nassau, N. P., Jan., '90.

(*e*) 2 broken. Near Nassau, N. P., Febr., '90.

The distribution of this species is circumtropical.

57. **Alpheus hippothoë,** De Man.
var. **bahamensis,** n. var. (Pl. xxx, Fig. 5).

(*a*) 24 specimens. Under coral and in pools between tides, New Providence.

(*b*) 3 specimens, one with ova. Nassau, N. P., Jan., '90.

(*c*) 2 specimens, one with ova.

This species is most closely allied to the variety *edamensis* of *Alpheus hippothoë* De Man, from the Bay of Bengal and Indian Archipelago (Arch. de Naturg., Bd. 53, p. 518, 1887). I am indebted to Dr. Ortmann for a communication from Prof. De Man comparing specimens from my material with his own *hippothoë*. As there are certain differences between the West and East Indian specimens I propose to make a new variety for the West Indian.

Total length from rostrum to telson, largest 24 mm., smallest 15 mm. Rostrum reaches nearly to end of first segment of inner antenna, sharp, laterally compressed, prolonged backwards as a distinct keel. Between keel and the prominent eyes a rounded depression. No ocular spines.

Inner antennæ: First joint of peduncle with small spine on outer surface; second joint nearly twice the length of proximal; terminal joint one-half the length of second. Shorter flagellum about the length of peduncle. Longer flagellum slender, about thrice the length of shorter.

Outer antennæ: Peduncle a little longer than that of inner, small spine on basal joint. Flagellum one third longer than long ramus of inner antenna, spinose portion of scaphocerite a little longer than the peduncle. Flabellar portion (scale) a trifle shorter; not quite so long as the peduncle.

Third pair of maxillipedes do not reach beyond end of peduncle of the outer antennæ.

First pair pereiopods: Large chela of largest specimen has a

length of 18 mm., of smallest specimen 8 mm. The large chela has a somewhat quadrangular depression on the outer surface, the distal end of which is continued upwards into a well-marked depression on the dorsal margin and extends backward as a groove along the inside of the dorsal surface. A distinct, but less marked depression on the ventral margin. Inner surface of the hand slightly hairy, outer surface nearly smooth. Fingers contorted, color in alcoholic material pale blue. Movable finger slightly longer than thumb. In the small chelapod, which may be on the right or left side, the finger is one-third the length of palm. Carpus of chelapods short. Meros triangular in section; ends distally in a sharp spine on the outer and inner angle. Distal end of meros reaches to end of peduncle of outer antennæ.

Second pair of pereiopods very long. Distal end of meros reaches beyond antennal peduncle. First and second joints of carpus sub-equal, each a little longer than third and fourth together. Third and fourth sub-equal. Fifth about two-thirds length of first; equal in length to fourth and fifth together. Finger about one-half length of thumb. (Fifth joint a little too short in figure.)

Third and fourth pereiopods short and stout, not quite reaching to distal end of meros of second. Length of meros less than three times its breadth. Carpus one half length of meros. *Both carpus and meros with spines on lower margin of distal end.* Propodos serrated on posterior surface.

Fifth pair of pereiopods shorter and more slender. Telson with median furrow. Two small spines on either side of furrow. Outer plate of uropod minutely serrated on end. A sharp spine on its outer distal angle.

Principal variations from *A. hippothoë*—

In new variety: Peduncle of outer antennæ longer than that of inner. Lamellar portion does not reach end of peduncle. Third maxillipedes do not reach beyond antennal peduncle. Relative lengths of carpal joints of seeond pereiopods differ.

Variations from *var. edamensis*—

Finger of small hand shorter than palm (longer in *eda-*

mensis). A quadrangular rather than a triangular depression on side of large hand.

First joint of carpus of second pereiopod is equal in length to second (shorter in *edamensis*). Third and fourth pereiopods less broad than in *edamensis*.

58. **Alpheus websteri** Kingsley.

Kingsley, Proc. Acad. Nat. Sci. Phil., p. 416, 1879.

(*a*) 3 specimens, one with ova. Along shore, near Nassau, N. P., Febr. 20, '90.

(*b*) 2 specimens, one with ova. Nassau, N. P., Jan. 10, '90.

(*c*) 3 specimens, fragmentary. Nassau, N. P., Jan. 10, '90.

Kingsley's type specimens were from Key West; it has been reported by Herrick from Nassau, N. P.

A. websteri is very probably the same as *A. formosus* Gibbs (Proc. Amer. Ass. Ad. Sci., p. 196, 1850). The descriptions apparently tally, though Gibbs makes no mention of the small black spine on the uropod which is mentioned as a characteristic feature by Kingsley and which is very evident in my specimens.

59. **Alpheus nigro-spinatus** n. sp. (Pl. xxx, Fig. 6).

(*a*) Two specimens. Under coral and in pools between tides, New Providence.

Carapace compressed. Rostrum short, acuminate, no longer than spines of ocular hoods; extended backwards as a ridge between the eyes, from each of which it is separated by a rounded depression. Spines of ocular hoods short, acuminate. The front of carapace is thus marked by three, nearly equal, small spines. Inner antennæ: Basal segment of peduncle with small spine (stylocerite); second and third segments, no spines but scattered hairs; second segment a little more than twice as long as the terminal; outer flagellum stouter and shorter than the inner. Outer antennæ: Outer angle of the basal joint of peduncle with a sharp, short spine; scaphocerite broad at base, outer margin produced into a strong spine which is longer than the inner, lamellar portion; distal end of terminal segment of

peduncle reaches to tip of scaphocerite. Third pair of maxillipedes reach about to the end of shorter flagellum of inner antennæ; strongly tufted with hair.

First pair of pereiopods: Larger hand much inflated, a slight, but distinct constriction on the upper margin near the articulation of the dactylus, and a deep constriction on the lower margin. Thumb contorted; a groove on the outer margin, the inner surface thickly covered with hairs and punctate. Dactylus contorted; extends slightly beyond thumb; inner surface with tufts of hair. Small hand (which on the one specimen is left, the other right) has a longer and more slender dactylus and thumb. Length of large hand 16 mm.; breadth 6.5 mm. Length of small hand 9 mm.; breadth 4 mm.

Second pair of pereiopods: Carpus five-jointed, proximal segment the longest, slightly longer than the second and third together; second and fifth segments each a little longer than one-half the length of first; third and fourth the shortest, subequal. Posterior pereiopods; meros without spines. Telson broadly triangular; extremity truncate; two small spines on either side of median line of dorsal surface; the outer ramus of uropod bears on its external distal angle a large, very black spine, which is distinguished from the similar black spine of *A. websteri* Kingsley (l. c., p. 416, 1879) by its much larger size and consequently more prominent appearance. Length of specimens 25 mm. and 22 mm. respectively.

60. **Alpheus minor** Say.

Say, Jour. Acad. Nat. Sci. Phil., I, p. 245, 1818.

Kingsley, Bull. U. S. Geol. Survey, IV, p. 190, 1878.

Bate, Challenger, Macrura, p. 558, Pl. C, 1888.

(*a*) numerous specimens, from brown sponges.

(*b*) 1 ♀ with ova. Along shore near Nassau, N. P., Febr. 20, '90.

(*c*) 10 specimens, from brown sponges.

Range: From Cape Hatteras (U. S. F. C. 1885) to St. Paul's Rock (Bate, Challenger). Both shores of Central America.

Collected at Jamaica, New Providence.

Lot (*c*) may possibly be a variety as the thumb is shorter than the typical *minor*, but otherwise there seems to be no difference.

61. **Alpheus saulcyi** Guérin.

Guérin, in Hist. du Cuba, 1857.
Herrick, Memoires Nat. Acad. Sci., Vol. V, p. 381.
(*a*) 5 specimens, from green sponges. Febr. '90.
(*b*) 1 specimen, near Nassau, Febr. 5, '90.
(*c*) 1 specimen, ♂, from green sponge.
(*d*) 1 specimen, from sponge, Mar. 1, '90.
(*e*) 1 specimen, from sponge, Mar. 1, '90.
(*f*) 2 specimens, Nassau, N. P., Jan., '90.
Range: West Indies.
Found at Nassau, Martinique.

62. **Athanas ortmanni** n. sp. (Pl. xxx, Fig. 7).

(*a*) 1 specimen. Along shore, near Nassau, N. P., Febr. 20, '90.

Rostrum slender and pointed, reaching a little beyond the second joint of peduncle of inner antennæ. Antero-lateral margin of carapace extends obliquely backward, prolonged in front of eye into minute spine. Eye-stalk short, not projecting beyond carapace. The eye is seen through the somewhat transparent carapace as in *Alpheus*. Inner antennæ, with stylocerite reaching to distal end of second segment of peduncle. From the peduncle arise two flagella of nearly equal length, the upper somewhat more slender than the lower, bearing on the fourth segment from base a minute, subsidiary flagellum.

Outer antennæ with scaphocerite nearly as long as the peduncles of inner antennæ, broad and fringed with hairs. Third pair of maxillipedes reach slightly beyond the distal end of scaphocerite.

First pair of pereiopods: That on the right side is robust with swollen chela, terminating in slender hooked fingers which are minutely serrated on the opposing edges. Margin of chela entire, length 5 mm., breadth 2.5 mm. Carpus

short. Distal end of meros reaches to extremity of third pair maxillipedes. Left chelapod lacking.

Second pair of pereiopods slender, with very small chelæ. Carpus five-jointed; proximal segment equal in length to the four distal segments. Remaining three pairs of perieopods similar to each other and equal in length to the second pair. Pleopods narrow and biramous. Telson narrow and compressed, with smooth margins. Uropods slightly longer than telson.

Total length of specimen 16 mm.

The species above described agrees generically with *Athanas* Leach (Edin. Ency., VIII, p. 432), with the exception that the eyes are entirely covered by the carapace. I propose, rather than found a new genus on the single specimen, to amend Leach's definition of *Athanas* by changing the statement, " Opthalmopoda short, scarcely reaching beyond frontal margin of carapace" (Bate, Challenger, Macrura, p. 528), to *ophthalmopoda short, covered by, or scarcely reaching beyond the frontal margin of carapace.*

There are four hitherto described species of *Athanas:*

A. nitiscens Leach. England and Norway, Mediterranean to Cape Verde Islands.

A. veloculus Bate (l. c., p. 529). Cape Verde Islands.

A. mascarenicus Richters (Beitrage zur Meeresfauna von Mauritius u. d. Seychellen, p. 164, 1880), Mauritius.

A. dimorphus Ortmann, Crust. in Semon's Forschungsreise (Jena. Denks., VIII, 1894, p. 12). East Africa : Dar-es-Salaam.

From all these species *A. ortmanni* may be distinguished at a glance by the form of the large chela.

PENÆIDEA.

Family **Penæidæ** Bate.

63. **Penæus constrictus** Stimpson.

Stimpson, Ann. Lyc. Nat. Hist. N. Y., p. 135, 1871.

Miers, Notes on the Penæidæ, Proc. Zoöl. Soc., London, p. 308, 1878.

(*a*) 1 ♂. Near Nassau, N. P., Febr. 1, 1890.
(*b*) 1 ♀. Nassau, N. P., Febr. 5, '90.
Range: East Coast U. S.
Not before reported from West Indies.
Collected by Stimpson at Beaufort, and Charleston, S. C.

STOMATOPODA.

Family **Squillidæ** Latreille.

64. **Pseudosquilla ciliata** Miers.

Miers, Ann. and Mag. Nat. Hist. (5), V, p. 108, Pl. III, 1880.
Brooks, Challenger, Stomatopoda, p. 53, 1886.
(*a*) 1 ♂ broken. Near Nassau, N. P., Febr., 1890.
Range: Widely distributed over Atlantic and Pacific.
Collected at Cuba, Bahamas, St. Thomas.

65. **Gonodactylus oerstedii** Hansen.

Hansen, Isopoden, Cumaceen und Stomatopoden der Plankton expedition, 1895.
(*a*) 1 ♀. Nassau, N. P., Febr. 5, '90.
(*b*) 1 ♀, fragmentary. Quarantine station, near New Providence, Jan. 25, '90.
(*c*) 1 ♀. Along shore near Nassau, N. P., Febr. 20, '90.
(*d*) 1 ♀. Nassau, N. P., Jan., '90.
(*e*) 1 ♂, 1 ♀, 1 fragmentary. Under coral and in pools between tides, near Nassau, N. P.
(*f*) 1 ♂. (label erased).
(*g*) 2 juv. Dredged in about 16 ft. near Quarantine station, Jan., '90.

Hansen, l. c. supra, p. 65 (and footnote), calls the West Indian *Gonodactylus*: *G. oerstedii* n. sp. and retains the name *G. chiragra* Fabr. for the East Indian form.

He says (footnote): "This species (*oerstedii*) may be distinguished from the East Indian form, *G. chiragra* Fabr., especially by the character, that it possesses a small keel inside of

and close to, the keel that ends in the sublateral process of the posterior margin, while such a secondary keel is wanting in the Indo-Australian species."

Collected at Bahamas, Cuba, Jamaica, St. Thomas.

CIRRIPEDEA.

Family **Lepadidæ** Darwin.

66. **Lithotrya dorsalis** Sowerby.

Sowerby, Genera of Shells, Apr., 1822.

Darwin, A Monograph of the Cirripedia, p. 351, Pl. VIII, 1851.

(*a*) 10 specimens. Salt Cay, N. P., in rocks in surf, Jan. 28, '90.

(*b*) 8 specimen. Salt Cay, Nassau, N. P., ocean side, Febr. 6, 1890.

Range: West Indies, Venezuela, Honduras.

Collected at Barbadoes.

Family **Balanidæ** Darwin.

67. **Acasta cyathus** Darwin.

Darwin, A Monograph of the Cirripedia-Balanidæ, p. 312, Pl. ix, 1854.

(*a*) 4 specimens, in sponge, dredged Jan. 22, '90.

(*b*) 2 specimens, near Nassau, N. P., Febr., '90.

Range: Madeira, West Indies (Darwin).

ISOPODA.

Two species of Isopoda, one probably a *Lygia* of which there are several specimens. Another parasitic on a fish, probably one of the *Cirolanidæ*.

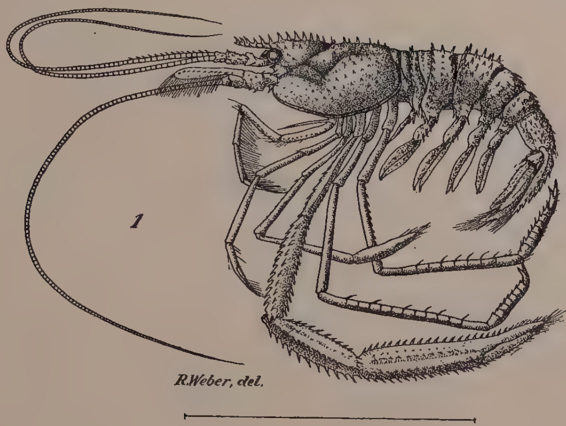
AMPHIPODA.

Several small amphipods undetermined.

PRINCETON UNIVERSITY,
April, 1898.

PLATE XXIX

PLATE XXIX.



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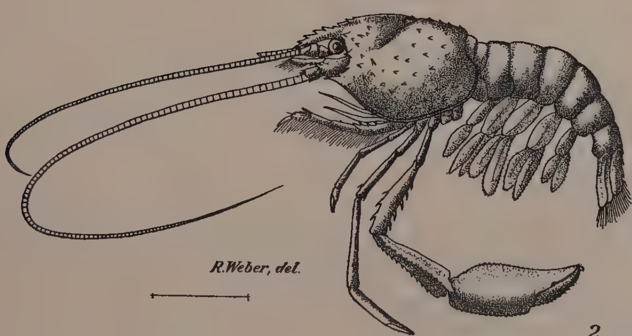
R.Weber, del.



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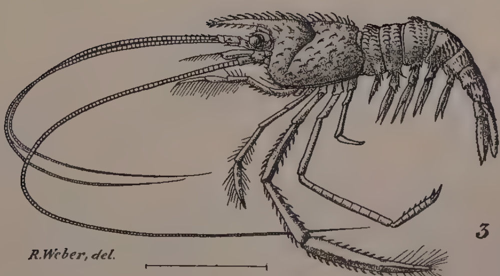

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PLATE XXX.

PLATE XXX.

		PAGE.
Fig. 4.	**Leander northropi** n. sp., RANKIN	245
Fig. 5.	**Alpheus hippothoe** DE MAN var. **bahamensis** n. var., RANKIN	247
Fig. 6.	**Alpheus nigro-spinatus** n. sp., RANKIN . . .	249
Fig. 7.	**Athanas ortmanni** n. sp., RANKIN	251


R.Weber, del.

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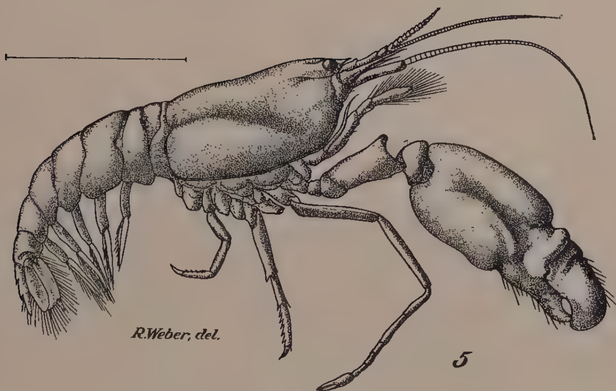
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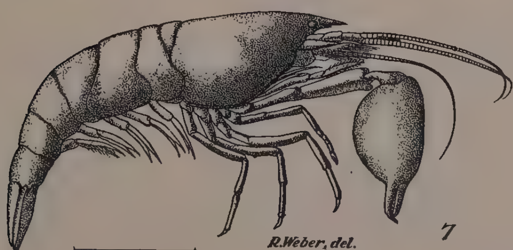
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ANNALS N. Y. ACAD. SCI., XI, No. 13, pp. 259 to 292, August 13, 1898.]

ON A COLLECTION OF CRUSTACEA FROM PUGET SOUND.

W. T. CALMAN, B.Sc.

[PLATES XXXI–XXXIV.]

THIS paper presents the results of an examination of the collection of Crustacea made in Puget Sound by the naturalists of the Columbia University Expedition in the summer of 1896, under the leadership of Professor Bashford Dean. I have also included a few additional species from a collection made in the same region by Professor D'Arcy W. Thompson, under whose supervision the paper has been prepared. I am indebted to Mr. N. R. Harrington, Fellow in Zoölogy in Columbia University, for many valuable notes on the specimens collected, the group Crustacea having been in his charge; and I have to thank the Rev. T. R. R. Stebbing for much kind assistance in connection with the AMPHIPODA.

Of the three new species described, the amphipod *Polycheria Osborni* is particularly interesting from the point of view of geographical distribution, since the only other member of the genus comes from the Southern hemisphere. The identification of the Japanese *Philyra pisum* adds another link to the many which already connect the fauna of the Western coast of America with that of the Japanese seas, as we may perhaps say that the first named specific connects it with the fauna of the Southern seas.

The following is a list of species collected by the Columbia University expedition.

DECAPODA.

Metacarcinus magister (Dana).
Cancer productus Randall.
Cancer gracilis Dana.

Lophozozymus bellus (Stimpson).
Trichocarcinus oregonensis (Dana).
Telmessus cheiragonus (Tilesius).
Heterograpsus nudus (Dana).
Heterograpsus oregonensis (Dana).
Pinnixa faba (Dana).
Scyra acutifrons Dana.
Hyas lyratus Dana.
Oregonia gracilis Dana.
Epialtus productus Randall.
Pugettia gracilis Dana.
Philyra pisum De Haan.
Eupagurus ochotensis Brandt.
" **middendorffii** Brandt.
" **tenuimanus** (Dana).
" **splendescens** (Owen).
" **granosimanus** Stimpson.
" **kennerlyi** Stimpson (?)
" **newcombei** Benedict (?)
Cryptolithodes typicus Brandt.
Hapalogaster mertensii Brandt.
Petrolisthes cinctipes (Randall).
Pachycheles rudis Stimpson.
Callianassa gigas Dana.
Upogebia pugettensis (Dana).
Sclerocrangon munitus (Dana).
Crangon franciscorum Stimpson.
Crangon affinis De Haan.
Nectocrangon alaskensis Kingsley
Paracrangon echinatus Dana.
Pandalus Danæ Stimpson.
Hippolyte prionota Stimpson.
" **gracilis** Stimpson.
" **sitchensis** Brandt.
" **grœnlandica** (Fabr.).
" **brevirostris** Dana.
" **lamellicornis** Dana.
" **stylus** Stimpson.

ISOPODA.

Livoneca vulgaris Stimpson.
Cirolana californica Hansen. (?)
Limnoria lignorum (Rathke).
Idotea Wossnessenskii Brandt.
" **resecata** Stimpson.
Ligia Pallasii Brandt.
Pseudione Giardi n. sp.
Argeia sp. (?)
Phyllodurus abdominalis Stimpson.

AMPHIPODA.

Hyperia galba Mont.
Orchestoidea californiana (Brandt).
Polycheria Osborni n. sp.
Mæra dubia n. sp.
Amphithoë humeralis Stimpson.
Amphithoë sp. (?)

COPEPODA.

Cecrops Latreillei Leach.

CIRRIPEDIA.

Pollicipes polymerus Sowersby.
Coronula diadema (L.).

RHIZOCEPHALA.

Sylon sp.

The following additional species occurred in Professor D'Arcy Thompson's collections :

Raphonotus (=**Fabia**) **subquadratus** Dana.
Paguristes turgidus Stimpson.
Echinocerus cibarius White.
Phyllolithodes papillosus Brandt.
Callianassa californiensis Dana.

BRACHYURA.

Cancer productus Randall.

Cancer productus Randall, Jour. Acad. Nat. Sci., Philadelphia, VIII, 116. 1839.

Cancer productus Dana, U. S. Expl. Exp. Crust., I, 156, Pl. vii, fig. 3. 1852.

Cancer productus Stimpson, Boston Jour. Nat. Hist., VI, 461. 1857.

Cancer productus Lockington, Proc. Calif. Acad. Sci., VII, 95. 1877.

One of our specimens has the carapace handsomely ornamented with a complex pattern of narrow red lines on a yellowish ground. The general direction of the lines is longitudinal, interrupted here and there by narrow, more or less symmetrical loopings. A series of three lines runs parallel to the antero-lateral margin, and at the front end converge, together with the adjacent longitudinal lines into the orbit. Lockington (l. c.) describes several color-varieties of this species from Monterey, Cal., one of which is "yellow with narrow red stripes, giving it a zebra-like appearance." This is no doubt the variety before us, though the complexity of the pattern is hardly sufficiently indicated by the epithet "zebra-like." Miss M. S. Rathbun has been good enough to inform me that there are similar specimens in the U. S. National Museum at Washington.

Philyra pisum De Haan.

Philyra pisum De Haan, Fauna Japonica, Crust., 131, Pl. xxxiii, fig. 7. 1850.

Philyra pisum Ortmann, Zool. Jahrb. Abth., f. Syst., VI, 582. 1892.

A single male specimen lacking both chelipeds and some of the ambulatory legs is referred to this species. I have been able to compare it with two specimens dredged in Yokohama Bay by Professor D'Arcy Thompson, and also with three specimens from the Strassburg Museum identified by Dr. Ortmann (l. c.) and sent to us by the great kindness of Professor L.

Döderlein, by whom they were collected in the same neighborhood. The resemblance in both cases is so exceedingly close that in spite of the imperfection of the Puget Sound specimen I have no hesitation in adding *P. pisum* to the list of species inhabiting both sides of the North Pacific. It is recorded from Japan by De Haan and Ortmann, and Mr. R. I. Pocock informs me that there is a specimen in the British Museum from the Philippine Islands.

MACRURA.

PAGURIDÆ.

The great number of closely allied species of *Eupagurus* occurring in the region under consideration, and the imperfect manner in which many of them have as yet been described, render the determination of the species a matter of difficulty in the absence of named specimens for comparison. In this respect I have derived great assistance from a valuable collection of marine invertebrates recently presented to the museum of University College by the Smithsonian Institution. In one or two of the cases where this help was not available I have marked with a query the names of species whose identification did not appear to be beyond doubt. The largest and commonest species of *Eupagurus* in Puget Sound, at first referred to as *E. alaskensis* Benedict in Messrs. Harrington and Griffin's paper on the Invertebrates of Puget Sound (Trans. N. Y. Acad. Sci., 1897, 159) is apparently, as mentioned in Mr. Harrington's paper on commensal nereids (ibid., p. 214), the *E. armatus* of Dana, which, however, Stimpson has identified with the earlier *E. ochotensis* of Brandt (Stimpson, Proc. Acad. Nat. Sci. Phil., 1858, p. 236).

LITHODIDÆ.

Cryptolithodes typicus, Brandt.

Cryptolithodes typicus Brandt, Bull. Phys. Math. de l'Acad. de St. Petersbourg, VII, 175. 1849.
Cryptolithodes typicus Stimpson, Boston Jour. Nat. Hist., VI, 472, Pl. xx, 1857.

The larger of the two specimens in the Columbia University collection agrees with Stimpson's figures and description of the type species, save that the marginal serrations are almost obsolete. The second very small specimen, however, is strikingly different in general appearance. The carapace is approximately triangular, the postero-lateral margins being nearly in a straight line, while the orbital notches are shallower, and the truncated rostrum more prominent than in any other specimens we have seen. A comparison of these and other specimens in the Museum of University College suggests the probability that some at least of the described species of this genus are based on characters varying with the age of the individual.

HIPPOLYTIDÆ.

The generic name *Hippolyte* has been used in its older and wider signification, since Spence Bate's subdivision of the genus (Challenger Rep. Macrura, p. 576) does not appear to be satisfactory.

Hippolyte prionota Stimpson.

H. prionota Stimpson, Proc. Acad. Nat. Sci. Philad., 1864. 153.
H. prionota Kingsley, Bull. Essex Inst. XIV, (1882), 127, Pl. ii, f. 9. 1883.

Kingsley's figure of this species shows the serrated dorsal crest passing in an even curve into the rostrum. In our specimens a slight depression separates the crest from the rostrum, and the latter is more truncate at the tip. Kingsley's figure omits the three orbital spines which are characteristic of the species.

Hyppolyte gracilis Stimpson.

H. gracilis Stimpson, Proc. Acad. Nat. Sci. Philad., 1864. 155.

A single somewhat damaged specimen is probably referable to this species. It differs from Stimpson's description in the fact that the most anterior of the four teeth on the rostrum

above is placed considerably in front of the eyes, while the external flagellum of the antennules falls short of the broken tip of the rostrum. As was the case with Stimpson's specimens, no epipod could be discovered on the third maxillipeds.

Hippolyte stylus Stimpson.

H. stylus Stimpson, Proc. Acad. Nat. Sci. Phil., 1864. 154.

Our specimens differ from Stimpson's diagnosis in the fact that the third maxillipeds are slightly longer, reaching a little beyond the extremity of the antennal peduncle to nearly the middle of the rostrum. Some of the smaller specimens show a minute pterygostomial spine, and in this respect resemble the allied *H. camtschatica* Stimpson. (Proc. Acad. Nat. Sci. Phil., 1860. 33.)

AMPHIPODA.

HYPERIIDÆ.

Hyperia galba (Mont.).

Cancer gammarus galba Montagu, Linn. Trans., XI, 4, Pl. ii, f. 2.

Hyperia galba, Sars, Crust. Norway; I—Amphipoda, p. 7, Pl. ii, iii.

Two specimens (♂ and ♀) agree very well with British examples of this somewhat variable species which has not hitherto been recorded from the Pacific.

ORCHESTIIDÆ.

Orchestoidea californiana (Brandt).

(Pl. XXXI, Fig. 1.)

Malorchestia californiana Brandt, Bull. Phys. Math. Acad. Imp. Sci., St. Petersburg, IX, 310–314. 1851.

Orchestia (*Talitrus*) *scabripes* Dana, U. S. Ex. Exp. Crust. II, 860, Pl. 57, f. 4. 1852.

Megalorchestia scabripes Stimpson, Bost. Jour. Nat. Hist. VI, 516. 1857.

M. californiana, Ibid.

Orchestoidea scabripes Spence Bate, Cat. Amph. Brit. Mus. II, Pl. I, f. 3. 1862.

O. californiana, Ibid., p. 14.

Description of Male.—Body robust, glabrous, lower edges of coxal and epimeral plates and all the appendages scabrid with short stiff setæ. Fifth pair of coxal plates having the anterior lobe larger than the posterior, angled below, while the posterior lobe is evenly rounded. Eyes slightly reniform, black. Superior antennæ not reaching the middle of the penultimate joint of the inferior, the three joints of the peduncle subequal, flagellum 9-jointed, hardly longer than half the peduncle. Inferior antennæ longer than the body and very stout. Last joint of the peduncle twice as long as the preceding, increasing in thickness to within a short distance of its distal end, the greatest thickness being nearly one-fifth of the length of the joint. Flagellum more than one and a-half times as long as the peduncle. Palp of maxillipeds three-jointed, second joint expanded inwards as a flat plate, last joint ovate. Inner plate with three conical teeth on distal margin. Anterior gnathopods not subchelate, carpus broader and much longer than the propodus, and having a large tubercle projecting from its lower or posterior edge near the distal end. Propodus cylindrical, having a slight swelling on its lower or posterior face distally. Posterior gnathopods very large, carpus small, propodus ovate, palmar edge oblique and not sharply defined from the posterior edge of hand, bearing a low rounded setose eminence near the articulation of the dactyl, and on the proximal side of this armed with about six short spines with intervening setæ. Dactyl strong, somewhat sharply curved near the base. Claw of second pereiopod bearing at about the middle of its concave side a blunt tooth, from within which springs a small seta. On the posterior legs the tooth is obsolete, but the seta remains. First pair of uropods having the rami subequal, not much shorter than the peduncle, both bearing spines on their outer and inner edges. Last pair of uropods having the single ramus lanceolate and longer than the peduncle. Telson small, triangular, rounded at the tip.

Length, 25 mm., superior antennæ 30 mm.

The identity of our species with that described by Brandt can hardly be doubted on comparing his characteristic though somewhat rough figure of the entire animal. His detailed figures are less successful, and in some points so obviously erroneous that we cannot attribute much weight to the discrepancies they show. The most important character in which our specimens differ from both description and figures is the absence from the palp of the maxillipeds of the minute unguiculate terminal joint on which Brandt lays stress as one of the distinctive characters of his new genus. It seems to us, however, that the resemblance in other details, especially in the antennæ and gnathopods, warrants our assuming an error of observation or possibly an abnormal specimen to account for the difference in the maxillipeds.

Our specimens agree closely with Dana's description and figures of his *Orchestia* (*Talitrus*) *scabripes*, in general aspect and relative proportions, in the shape and size of the two pairs of gnathopods, and in the scabrous character of the limbs. They differ, however, in the length of the last joint of the peduncle of the inferior antennæ. Dana states this joint to be "more than twice the preceding in length," and his figure (of which a very faulty reproduction is given in Cat. Amph. Brit. Mus., Pl. I, f. 3), shows the proportion to be 2.7:1, while the diameter is one-tenth of the length. In our specimens this joint is only very slightly more than twice the length of the preceding, and its diameter is one-fifth of its length. A minor point of difference is that Dana states the outer ramus of the first pair of uropods to be naked. In our specimens both rami are equally furnished with setæ.

Stimpson, who may have examined specimens referred to both species, records them as distinct, stating that Brandt's species differs from Dana's "among other characters in the great length of the fifth epimeral," a point on which Brandt's figure is obscure, while our specimens agree perfectly with Dana's. Stimpson also states that the feet of *M. californiana* are not scabrous. It seems to us, however, that our present knowledge entitles us to regard the species as synonymous, on the probable

assumption that the last peduncular joint of the antennæ may vary somewhat in length.

Brandt's species formed the type of his genus *Megalorchestia*, and was transferred by Spence Bate to the synonymous *Orchestoidea* of Nicolet. I have not been able to refer to Nicolet's work, but in his definition of the genus quoted in Stebbing's Challenger report (p. 231), it is stated that the palp of the maxillipeds is four-jointed. Mr. Stebbing, however, informs me that this is an error, the figure given by Nicolet showing that only three joints are present. *Talitronus* of Dana is another synonym of *Orchestoidea* (Stebbing, *op. cit.*, p. 262).

The female of *O. californiana* has not been identified. It seems not improbable, as Mr. Stebbing has suggested to us, that Dana's *O. pugettensis* may prove to be the female, the scabrous character of the legs in *O. californiana* being the only character which stands in the way of this supposition.

ATYLIDÆ.

Polycheria osborni n. sp.

(Pl. XXXII, Fig. 2.)

This species closely resembles *Polycheria antarctica* (Stebbing),[1] but differs from it in the following details :

The dorsal processes of the urosome are much less prominent (Fig. 2, *ur*).

In the maxillipeds the outer plates are longer, nearly equalling the palps and bearing each only about eleven spines on the inner edge (instead of 18–19).

The propodus of the first gnathopods is somewhat differently shaped, the palmar edge, against which the dactyl closes, being very short, not more than one-third the length of the dactyl.

In the second pair of gnathopods the hand is more than twice

[1] *Dexamine antarctica* Stebbing, Ann. Mag. Nat. Hist. (4) XV, 184, Pl. XV, A. f 1. ; *Tritæta Kergueleni*, Stebbing. Challenger Report Amphipoda, pp. 941–945, Pl. LXXXIII ; *Polycheria antarctica* (Stebb.) Della Valle. Monogr. Gamm, 580.

as long as broad, and the palmar edge extends to about one-half the length of the dactyl.

The coxal plates of the second pair of pereiopods, which in *P. antarctica* resemble those of the first pair in being produced anteriorly into a long sharp spine, are here different, and have the anterior process reduced to a short blunt lobe.

The propodus of the third pereiopods differs in shape from that of *P. antarctica*, the thumb-like process being much less prominent and the anterior and posterior edges nearly parallel.

The first maxillæ have the palp composed of only one joint, but Della Valle has already pointed out (Monogr. Gammarini, p. 579) that Stebbing was misled in ascribing a two-jointed palp to *P. antarctica*.

Length, 7 mm.

8 specimens, all females bearing ova, "in nests in *Amarœcium*."

The various other species of *Polycheria* which have been described, are probably all referable to one, *P. antarctica* (Stebbing), with a wide distribution in the Southern Ocean (Kerguelen Island, Antarctic Ocean, New Zealand, Australia). The occurrence of a second species in the Northern hemisphere is, therefore, interesting.

At the suggestion of Professor D'Arcy Thompson I have dedicated this interesting species to Professor H. F. Osborn, of Columbia University, New York.

Gammaridæ.

Mæra dubia n. sp.

(Pl. XXXII, Fig. 3.)

Description.—Body moderately slender and compressed, sparsely covered with very small scattered setæ. Lateral lobes of head short, truncate. First pair of coxal plates produced forwards and pointed, slightly less deep than the corresponding segment. Fourth pair nearly twice as long as deep, and about half as deep as the corresponding segment.

Epimeral plates of metasome, each with a slight tooth at the posterior lower corner. Eyes small, dark. Superior antennæ about half the length of the body; first joint of peduncle about one and a-half times as long as the head, short at the base and tapering at the tip, where it is armed below with a small spine; second joint of equal length with the first, much more slender; third joint one-third the length of the second; flagellum about two-thirds the length of the peduncle; accessory flagellum about as long as the last joint of the peduncle, seven-jointed. Inferior antennæ not quite two-thirds the length of the superior; last joint of peduncle three-fourths the length of the preceding and about equalling the short flagellum. Anterior gnathopods of moderate size; hand scarcely broader than, and equal in length to the carpus, ovate in form, the palmar edge oblique and not sharply defined. Second gnathopods large, merus produced into a sharp tooth at its lower distal corner. Carpus triangular, its distal margin equalling in width the adjacent part of the propodus. Propodus oblong quadrangular, twice as long as broad, anterior and posterior margins slightly curved, palmar edge oblique, irregularly serrate, defined by a tooth. Dactyl equalling the palmar edge. Both gnathopods with tufts of long setæ especially on the margins. Last three pairs of pereiopods with the basal joints expanded, ovate, with the posterior edge almost smooth. Last pair of uropods longer than the urosome, rami subequal, more than twice as long as the peduncle.

Length, 13 mm.

The only species of amphipod hitherto described from the west coast of North America which appears to resemble the present form is the *Mæra fusca* of Spence Bate (Proc. Zool. Soc. Lond., 1864, p. 667). The few details given by that writer render the recognition of the species very difficult. It is stated, however, that the palmar edge of the gnathopods is without serrations, a character which would seem to distinguish *M. fusca* from the present species. Mr. Stebbing has called our attention to several other species not very different in appearance from the present. Of these *Gammarus furcicornis* Dana,

from the Sooloo Sea, is perhaps the one most closely approaching ours. It differs, however, in the much longer accessory flagellum of the upper antennæ, the shorter and broader hand of the second gnathopods, and the greater hairiness of body and limbs.

Having in view the great difficulty of recognizing with certainty many of the species indicated by the older authors in the difficult group of Amphipoda to which this form belongs, we have judged it best to give a new name to the species described by us, for convenience of reference, at least until it can be shown to be identical with some of the earlier species.

PODOCERIDÆ.

Amphithoë humeralis Stimpson.

Amphithoë humeralis Stimpson, Proc. Acad. Nat. Sci., Philadelphia, 1864, p. 156.

Description.—Body rather compressed. Lateral lobes of head very little prominent, rounded. Anterior pairs of coxal plates about equal in depth to the corresponding segments; fourth pair large, quadrangular, the posterior lobe small and rounded. Eyes small, rounded, close to lateral lobes of cephalon, pigment dark. Superior antennæ more than half the length of the body; first joint of peduncle stout, about equal in length to the head and to the rather more slender second joint; third joint very small, about one quarter the length of the preceding, and much narrower; flagellum two and a-half times the length of peduncle. Inferior antennæ stout, more than half the length of the superior, last joint of peduncle a little shorter than the preceding, flagellum a little more than half the length of peduncle. Lower lip having the posterior cornu of outer lobe large. Palp of mandible having last joint longer than the preceding, not expanded. Outer lobe of second maxilla broader, but scarcely longer than the inner. Palp of maxillipeds having the first joint slightly produced exteriorly where it forms a distinct shoulder tipped with a tuft of long setæ; outer plates hardly reaching beyond second joint of palp. Gnathopods similar in the two

sexes, rather slender, and densely setose. First pair having the carpus longer than the hand, its lower edge convex; propodus quadrangular, about two and a-half times as long as broad, lower edge convex with a shallow concavity distally behind the prominent anterior corner; palmar edge very short, transverse, overlapped by the serrated dactyl. Second pair of gnathopoda having the carpus slightly longer than the propodus, its lower edge produced into a rounded lobe; propodus hardly more than twice as long as broad, shaped as in the first pair, palmar edge somewhat longer but still shorter than the dactyl. First and second pairs of pereiopods similar, basal joint expanded, ovate, twice as long as broad; merus with its anterior margin expanded and regularly arcuate, produced distally in front and overlapping the carpus for one-fourth of its length. Third pair of pereiopods very short, fourth pair hardly extending to end of carpus of fifth pair which are long and slender. Last pair of uropods not reaching beyond the preceding pair, peduncle three times as long as the rami, outer ramus with two strong hooks, inner ramus lamellate, truncate, bearing setæ. Telson triangular, truncate, with a few setæ on each side.

Length, about 26 mm.

The identity of this form with the species observed by Stimpson is at once suggested by his description of the first two pairs of pereiopods, "with the basal joint very large and much expanded, nearly as broad as their epimera; meros-joint in the same pairs small, compressed, with a sharp arcuated anterior margin." The small size of the "subpediform" gnathopoda in both sexes and other less characteristic points are quite in accordance with our specimens. On the other hand, the superior antenna is stated to be "nearly as long as the body." The inferior antenna is "half as long as the body, with its flagellum no longer than the antepenult joint of the peduncle." Though we should probably read "last" or "penultimate" for "antepenult," the length of flagellum indicated is still less than in our specimens. It does not seem to us, however, that these discrepancies are sufficiently important to prevent the identification of our specimens with the species described by Stimpson.

The question whether *Amphithoë humeralis* may be identical with some of the older species is one which it is not possible to answer satisfactorily in the present state of our knowledge. Mr. Stebbing (Chall. Rep. Amph., 351) compares it with Spence Bate's *A. falklandi* (Cat. Amph. Brit. Mus., 237, Pl. XLI, f. 6) and he afterwards (op. cit., p. 1124) notes the resemblance between the latter species and Dana's *A. brevipes* (U. S. Expl. Exp. Crust., II, 941, Pl. 64, f. 5). *A. falklandi*, however, differs, according to Spence Bate's account, from the present species in the fact that the last pair of uropods project much beyond the preceding, while the last two pairs of pereiopoda are said to be subequal. In *A. brevipes* Dana the posterior gnathopods of the male are large and quite different in shape from those of the present species.

Amphithoë sp.

A second species of *Amphithoë* is represented by an imperfect female specimen about 18 mm. long. The coxal plates are very large, about twice as deep as the corresponding segments. Both pairs of antennæ rather slender, upper pair half as long as body, lower about two-thirds as long as upper. Flagellum of lower pair about half as long as peduncle. Gnathopoda stronger than in preceding species, second pair larger than first, hands ovate, palm oblique and defined by a tooth. Second pair of pereiopods (the first are missing) with basal joints not expanded, merus not strongly arched in front. Fourth and fifth pairs of pereiopods rather slender, subequal, with tufts of long setæ especially at tip of propodus. Body and appendages sprinkled with minute reddish-brown pigment spots.

The single mutilated specimen offers no striking characters to differentiate it from several of the other and imperfectly known species, and indeed in this family the distinction of species in the female sex are frequently so obscure that we cannon venture on a more precise determination. It may be noted, however, that in general aspect and particularly in the long setæ of the posterior pereiopods it resembles Dana's *A. filicornis*, from Rio Janeiro, and it may not improbably be the species re-

corded under that name by Spence Bate from Esquimalt, in J. K. Lord's "Naturalist in Vancouver Island" (from Zoölogical Record for 1866). It differs, however, from Dana's species in the much shorter lower antennæ and deeper coxal plates.

ISOPODA.

CIROLANIDÆ.

Cirolana Californica, Hansen (?).

C. Californica, Hansen, Cirolanidæ, Vidensk. Selsk. Skr., 6 Raekke, Naturvid. og Math. Afd., 3, 1890, p. 338. Pl. iii, f. 2.

The specimen which we refer with some doubt to this species is a male, about 20 mm. long. The body is proportionately narrower (7 mm.) than in Hansen's species. The antennæ hardly reach beyond the second thoracic segment. The last segment of the abdomen hardly broader than long, more acute than in Hansen's figure and with only 14 spines on the tip.

BOPYRIDÆ.

Pseudione Giardi n. sp.

(Pl. XXXIV, Fig. 5.)

Description of Female.—The single specimen, measuring 12 mm. in length, was taken from the right branchial cavity of its host (*Eupagurus ochotensis* (Br.)), and it is, accordingly, a dextral individual (*Bopyre droit* Giard & Bonnier), though the outline of its body seems at first sight to indicate a sinistral curvature, from the concavity of the right margin in the region of the posterior thoracic segments. Closer examination, however, shows that the head and the abdominal region are turned towards the left, and that the pleopods of the right side are longer than those of the left, as in a normal dextral individual, so that the peculiar curvature of the body is, in all probability, merely an accidental variation.

The specimen shows no traces of pigmentation. The dorsal surface is flat or slightly concave, the ventral is convex and is covered, except in the region of the abdomen, by the greatly developed brood-pouch. The dorsal swelling of the cephalic region which marks the position of the stomach (*cephalogaster*), is very slight. An irregularly oval, somewhat convex, area, the "ovarian bosse," is marked off by a groove on each side of the first four thoracic segments on the dorsal surface.

The abdominal segments, six in number, are distinctly separated from each other. The ventral surface of the abdominal segments and of the last two or three thoracic segments is roughened by longitudinal rugæ, which are most marked on the adjacent margins of the segments. These rugæ are neither so conspicuous nor so regularly disposed as in the case of the allied *Palægyge borrei* described by Giard and Bonnier (Bull. Scient. Fr. et Belg., XIX, 68, 1888). The anterior margin of the head is bordered by a narrow membranous expansion (*limbe antérieur*, G. & B.), which shows a distinct notch and several fainter undulations on each side of the middle line. No trace could be discovered on the thoracic segments of the pleural lamellæ, which in *Palægyge* are said to be "rudimentaires et à peine visibles."

The antennules (inner antennæ) are short, conical, composed of three joints and bearing a few very minute setæ at the tip. The antennæ (outer antennæ) are composed of five joints, of which the first is indistinctly marked off from the lower surface of the head; the third is longer and much more slender than the second, the fifth is very minute. The mandibles, which are embraced by the upper and lower lips to form the characteristic "beak" of the *Epicaridea*, are of the usual shape. The first pair of maxillæ appear to be absent. After a careful examination we have been unable to find any distinct rudiments of them, though the triangular areas between the base of the mandibles and the lower lips on each side bear some resemblance to the rudiments of these organs in *Palægyge* (Giard and Bonnier, tom. cit., Pl. V, f. 2). The rudiments of the second maxillæ are to be detected further back on the under surface of the head. Immediately in front of each a relatively large opening leads into

a capacious tube lined by an invagination of the chitinous cuticle, the protuberance interpreted as the rudiment of the second maxilla forming the lower or posterior lip of this orifice. Unfortunately, these tubes were not discovered till the soft parts of the head had been removed by caustic potash, so that we are unable to say anything as to their connections inside the body. This is the more to be regretted since we know of nothing analogous to these organs, not only in the *Epicaridea* but even among the *Malacostraca*.

The maxillipeds are similar to those of *Palægyge* but somewhat narrower. Each consists of a flat, roughly quadrangular plate partially divided into two parts by an oblique line. The posterior part has its external angle rounded and pointed as in *Palægyge Borrei*, and the antero-internal angle is produced. The anterior margin of the maxilliped bears a few setæ, and at its inner angle is articulated the small "palp," also setose.

Posteriorly, the lower surface of the head terminates in a freely projecting lamina, the "*limbe postérieur*" of Giard and Bonnier. In the present species this lamina is cut up into a fringe of digitate processes commencing on each side a little way from the middle line and increasing in size outwards. Externally, on each side the lamina is produced into a long process, narrowing gradually from its base to a rounded tip, turned inwards and extending beyond the middle line. In *Palægyge* there are two pairs of shorter processes and no fringe of minute digitations.

The thoracic legs are all similar and of the usual structure. The "adhesive cushions" present on the proximal segments of the first pair in *Palægyge* are here absent. The oöstegites or brood lamellæ were unfortunately injured in the single specimen found. The usual five pairs are present and are much larger than in *Palægyge Borrei*, all the pairs except, perhaps, the third and fourth, overlapping across the median line. The first pair are, as usual, of somewhat complex form. Roughly quadrilateral in shape, the posterior corner is produced into a hook-like process directed inwards. A little behind the middle of its length the lamella is crossed by a transverse fold, form-

ing on its outer or lower surface a deep groove, the anterior margin of which is produced as an overlapping ridge. On the inner, or in its natural position upper, face of the lamella, the fold projects as a strong ridge which for part of its length is fringed with digitate processes. The front edge of the second pair of oöstegites is received into the groove on the lower surface of the first pair. The last two pairs are strongly fringed with setæ on the posterior edge.

Five pairs of biramous pleopods are present, successively diminishing in size posteriorly; those of the right side being, as already mentioned, considerably larger than those of the left. In the first pair the exopodite (lobe *b*, according to the nomenclature of Giard and Bonnier) is roughly quadrilateral in shape and much smaller than the endopodite (lobe *c*), which is long and pointed. In the posterior pairs the exopodite approaches more closely in size and shape to the endopodite. The last segment of the abdomen is very small and bears articulated to its posterior margin a pair of lanceolate lamellæ, of which the right is broader and slightly longer than the left. These lamellæ may possibly represent the sixth pair of pleopods, but a comparison with Giard and Bonnier's figure of the corresponding region in *Palægyge Borrei* suggests that we have here to do with the rudimentary pleural lamellæ (lobe *a* of Giard and Bonnier), which, separated by a distinct suture from the fifth and sixth segments in the last-named species, are here only distinct on the sixth segment. If this view be adopted the sixth pair of pleopods are entirely absent. In all the pleopods the surface of the endopodite is roughened by irregularly transverse rugæ which are most distinct on the anterior pairs.

Male.—A male individual about 3 mm. long was found under the pleopods of the female. The body is symmetrical, lanceolate in outline, the fourth thoracic segment being the widest. A pair of eyes are present near the posterior corners of the head. Both antennules and antennæ are well developed, the former having three, the latter five segments. As in the female, no distinct rudiments of the first maxillæ could be identified. The second maxillæ have the form of rather large, rounded tubercles.

The maxillipeds are present as long slender processes each tipped by a single seta, inserted on each side close to the base of the lower lip. The seven pairs of thoracic feet are all similar and of the usual form, with powerful subchelate terminations.

The six abdominal segments are distinct, regularly diminishing in size posteriorly, and the first five show rudiments of pleopods in the form of slight rounded eminences on the ventral surface. In *Palægyge Borrei*, Giard and Bonnier describe the male as having rudiments of pleopods on the first three abdominal segments only (l. c., p. 70), but in a later paper the same authors speak of the abdominal segments of the male in the genus *Palægyge* as being *all* furnished with these rudiments. (Bull. Scient., XXII, 373. 1890.) The last segment of the abdomen is very small, cordate in form, being very narrow anteriorly and having its hinder margin notched; its greatest breadth is about equal to the length.

Larva.—The brood-pouch of the female was filled with embryos just hatched, and having the form characteristic of the first larval stage of the *Epicaridea*. The head is large and projects in front in a rounded hood-like form. The antennules are in the form of rounded tubercles bearing a number of stout spines among which a narrow pointed process appears to represent the rudiment of the flagellum. The antennæ are about half the length of the embryo, not yet distinctly segmented, and armed at the tip and about the middle of their length with a few spines.

The mouth parts are still in a very early stage, and are difficult to interpret. In the middle the rudiment of the upper lip can be made out, and immediately behind it are a pair of minute lobes in contact with each other in the middle line. Behind this and at some distance from the middle line on each side are three finger-like appendages, the last of these being minutely forked at the tip.

Walz figures (Arb. Zoöl. Inst. Wien. IV, 2, Pl. I, f. 3a) an embryo of *Bopyrina virbii* at a stage apparently corresponding to that of the present specimens. The upper lip and the pair of small lobes close to it are shown, but there are only two pairs

of finger-like processes where our specimens show three. The first pair, Walz states, develops into the mandibles, and he suggests that the second pair corresponds to one of the pairs of maxillæ which by fusion give rise to the lower lip (*l. c.*, p. 14). The latter part of his suggestion appears hardly probable. The minute lobes behind the upper lip are not referred to in the text.

The figure which Giard and Bonnier give of the mouth parts of an embryo of *Cancrion miser* (Contr. à l'etude d. Bopyriens, Pl. IX, f. 13), though taken from an earlier stage, corresponds fairly well with our specimens. Two small lobes close to each other, lettered *lb* in their figure, are evidently the same as those which we have lettered *I*. The figure does not seem to be fully discussed anywhere in the text of the monograph, but in the explanation of the plate the interpretation of the letters is given as "première paire d' appendices buccaux (labre)." In their figure of a newly-hatched embryo of *Portunion Kossmanni* (*op. cit.*, Pl. X, f. 1), a pair of appendages exactly similar in shape and position are lettered as mandibles. In *Cancrion* three pairs of appendages follow upon those just discussed. Of these the first two pairs are simple and are interpreted as mandibles and first maxillæ, while the third pair are biramous and are identified as the maxillipeds. In *Portunion* only two pairs of appendages are present in the corresponding position, both simple and lettered as first maxillæ and maxillipeds.

We cannot attempt to reconcile these seemingly contradictory accounts of species which we have not studied, and shall only indicate what seems to be the most probable interpretation of the specimens before us. The rudiments which we have lettered *I* seem, from their position close together in the median line, to be the paragnatha which afterwards fuse to form the lower lip. This leaves three pairs of rudiments to be allotted between the four pairs of appendages from mandibles to maxillipeds, and we may assume one of the pairs of maxillæ to be missing (probably the first pair, which appears to be absent in the adults of both sexes). On the other hand, it is possible that the rudiments *I* may, in spite of their small size and median position, represent the mandibles, in which case the other appendages

are satisfactorily accounted for. In either case the pair iv probably represent the maxillipeds, the minute bifurcation at the tip recalling the biramous character of these organs in the embryos of *Cancrion* and of *Cepon* (Giard and Bonnier, Bopyriens, Pl. III, f. 6 and 7).

The completely segmented abdomen of both sexes, the biramous pleopods of the female and the presence of rudimentary pleopods in the male, would refer this species to the genus *Palægyge* as established by Giard and Bonnier in 1888 (Bull. Scient., XIX, 63). The fact that the species infests a pagurid, and the rugosity of the pleopods in the female would place it in the second division of that genus recognized by these authors in 1890 (Bull. Scient., XXII, 373), to which, adopting Stebbing's suggestion (Hist. Crust., 411), we may apply the earlier name *Pseudione*, Kossmann. Of the species enumerated by Mr. Stebbing as referable to the latter genus, three; *P. Fraisci* (Kossmann), *P. Dohrni* (G. & B.), *P. insignis* (G. & B.), appear to be *nomina nuda*, regarding which no particulars save the names of their hosts are recorded. Of *P. callianassæ* Kossmann, only the male appears to be described, and from the account given by Kossmann (Z. f. W. Z., XXXV, 663, Pl. XXXIII, f. 37), and reproduced by Giard and Bonnier (Bopyriens, pp. 77–8), we learn that that species agrees with our form in the presence of rudimentary maxillipeds in the male, though these rudiments are very much smaller in Kossmann's species than in ours. Moreover, rudiments of the first maxillæ, which we have not found, are figured as present in that species.

In *Pseudione Hyndmanni* (Bate & Westwood), described in the British Sessile-eyed Crustacea (p. 243), as *Phryxus Hyndmanni*, from *Eupagurus bernhardus* (L.), the general features of the female appear to approximate very closely to our species. The pleural lamellæ of the abdomen, however, appear to be rounded instead of pointed, and those of the last segment are shorter and broader. The pleopods are smaller and less unsymmetrical.

In *Pseudione confusa* (Norman), from *Galathea dispersa* Bate, described in the above mentioned work (p. 249) as *Phryxus galatheæ*, the brief description and imperfect figures of the fe-

male offer no marked distinction from the present species. In the male, however, the abdomen tapers much less rapidly and the last segment is twice as broad as long. The thoracic segments are somewhat more expanded laterally, and the last thoracic is considerably wider than the first abdominal segment. It is stated that "the small conical mouth appears to be protected on each side by a minute 2-jointed foot jaw," but it does not seem probable that the appendages figured are really the maxillipeds.

While the few details available in the case of these species render it impossible to enumerate the characters which distinguish *Pseudione Giardi* from the other members of the genus, it appears to be most closely allied to *P. Hyndmanni*, as was, indeed, to be expected from the nature of its host. Its precise specific delimitation can only be effected when we are in possession of fuller information with regard to the last named and other species.

I have recently received by the kindness of the author a copy of Dr. Hansen's beautiful memoir on the Isopoda of the "Albatross" expedition (Bull. Mus. Comp. Zool., XXXI, 5, 1897), in which he describes and figures *Pseudione galacanthæ* from the deep-sea galatheid *Galacantha diomedeæ.* In spite of the very different host and habitat the new species appears to differ only in trivial characters from our own. Dr. Hansen however recognizes a rudiment of the first maxilla in both sexes where we have only been able to see the membranous interspace between the mandible and the labrum.

Argeia sp.

Two specimens on *Crangon affinis*, De Haan. Both specimens were in very bad condition, having been apparently allowed to dry, and nothing could be made out of their structure. Relying, however, on the principle of MM. Giard and Bonnier, that no species of the *Epicaridea* infests more than one species of host, we may conjecture that these represent a new species of *Argeia* in addition to the two already known from the west coast of America; *A. pugettensis*, Dana, on *Sclerocrangon munitus* and *A. pauperata*, Stimpson, on *Crangon franciscorum.*

Phyllodurus abdominalis Stimpson.

P. abdominalis Stimpson, Boston Jour. Nat. Hist., II, 511. 1857.

Of this interesting and imperfectly known form a large series of both sexes and different stages of growth was obtained. These it is proposed to describe in detail in a later paper. It may be mentioned that the male of this species was recorded and briefly described by Lockington in 1876, in a paper whose title affords no clue to this part of its contents ("Descr. of a new gen. and sp. of Decapod Crustacean," Proc. Calif. Acad. Sci. (1876), 1877, p. 57).

LIGIIDÆ.

Ligia Pallasii Brandt.

Ligia Pallasii Brandt, Conspectus Monogr. Crust. Oniscid. Bull. Soc. Imp. Nat., Moscou, VI, 171. 1833.
Lygia dilatata Stimpson, Bost. Jour. Nat. Hist., VI, 507, Pl. xxii, f. 8. 1857.
Ligia Stimpsoni Miers, Proc. Zoöl. Soc. Lond., 1877. 671.
Ligia Pallasii Budde-Lund, Isop. Terr., 261. 1885.

Of the species described in Budde-Lund's Monograph our specimens approach most closely in the proportions of the uropods to *L. Pallasii* Br., from which they differ only in the much narrower body. Stimpson, however, mentions that the relative width of the body is subject to great variation. The *L. septentrionalis* of Lockington (Proc. Calif. Acad. Sci. (1876), 1877, p. 46), a species not mentioned by Budde-Lund, agrees with our specimens so far as the short description goes, but its distinctness from *L. Pallasii* does not appear to be beyond doubt.

The dimensions of our two specimens are as follows :

Length.	Breadth.	Antenna.	Uropods.
31	16	16	4.5 mm.
21	10	12.5	4 mm.

RHIZOCEPHALA.

Sylon sp.

A single specimen of a *Rhizocephalan*, probably referable to this genus, was in the collections sent me, and I understand that further specimens were obtained. In Messrs. Harrington and Griffin's paper on the Puget Sound Invertebrates (Trans. N. Y. Acad. Sci., 1897, p. 164) a "*Sacculina*" is recorded as occurring on *Sclerocrangon munitus* (Dana). From a sketch kindly sent me by Mr. Harrington I gather that a specimen occurred on a *Pandalus Danæ* Stimpson. In the specimen sent to me, only the abdomen of the host is preserved and this is certainly not that of a *Pandalus* nor of a *Sclerocrangon*, but apparently belongs to some species of *Hippolyte*.

The parasite is attached as usual to the under surface of the third abdominal segment of its host. It has an ellipsoid shape, the longest axis lying nearly parallel to the longitudinal axis of the host's body and measuring about 4 mm. Transversely to the body of the host the parasite has a diameter of 3.4 mm. and its vertical depth is 3 mm. The base of attachment is about 2 mm. in diameter and somewhat nearer the posterior pole. The genital openings could not be detected (Hoek states, in his appendix to the Challenger Report on the *Macrura*, p. 923, that these openings are closed in young specimens), nor was any trace of the mesenteric line visible. The branched "roots" are easily visible inside the body of the host. Hoek states (Ib., p. 924) that in *Sylon*, contrary to what obtains in *Sacculina*, the roots do not reach the intestine of the host, but are, for the most part, confined to the space between the ventral muscles of the abdomen and the integument. In our specimen, however, the roots penetrate further into the body and form a plexus surrounding the intestine.

APPENDIX.

Since the above paper was written I have received from Mr. N. R. Harrington a few Crustacea which had been overlooked in sorting out the Puget Sound material. Among them is a specimen of a small *Slerocrangon* closely resembling but apparently distinct from *S. muricus* (Dana). I believe it to be identical with a species to be described by Mr. A. O. Walker in a forthcoming paper in the Proc. Biol. Soc. Liverpool, and of which Mr. Walker has been good enough to send me a sketch. His specimens were dredged in Puget Sound by Professor Herdman, of Liverpool.

The collection sent me also includes a second specimen of *Sylon*, attached to a *Hippolyte brevirostris* Dana.

UNIVERSITY COLLEGE, DUNDEE, SCOTLAND.

PLATE XXXI.

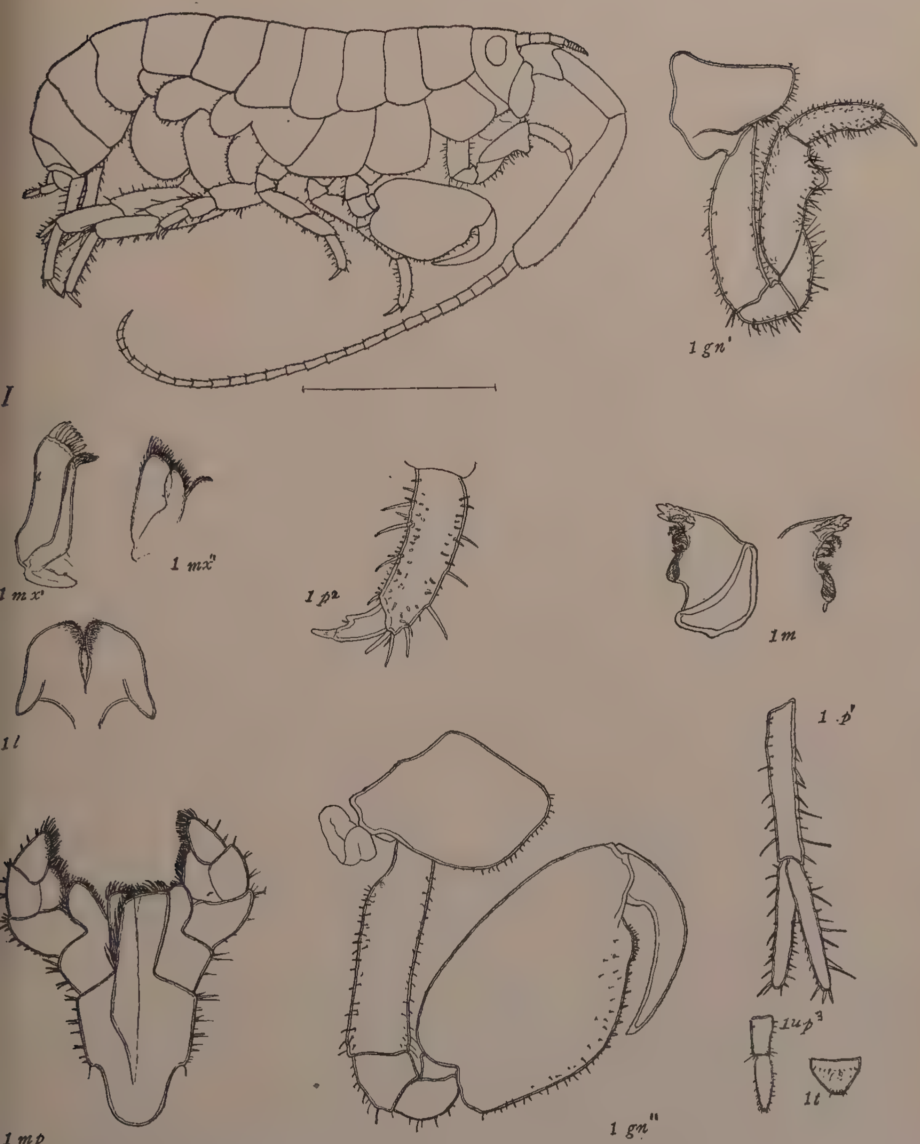
PLATE XXXI.

Fig. 1. **Orchestoidea californiana** (Brandt). Male.

Reference Letters.

ant'.—Antennules.
ant''.—Antennæ.
as.—Anal style.
bucc.—Mouth parts.
ceph.—Under surface of head.
emb.—Embryo.
en.—Endopodite.
ex.—Exopodite.
gn', *gn''*.—Gnathopods.
l.—Labium.
la.—"Limbe antérieur."
lp.—"Limbe postérieur."
lbr.—Labrum.
m.—Mandible.
mp.—Maxilliped.
mx', *mx''*.—Maxillæ.
p', p^2, etc.—Pereiopods.
pl.—Abdomen.
pl^{I}, pl^{VI}.—Pleural lamellæ.
plp.—Pleopod.
up.—Uropod.
ur.—Urosome.
t.—Telson.

I, II, III, IV.—Mouth parts of embryo (see text).



W. T. C. ad nat. del.

PLATE XXXII.

PLATE XXXII.

Fig. 2. **Polycharia Osborni** n. sp. Female.
Fig. 3. **Macra dubia** n. sp.

Reference Letters.

ant'.—Antennules.
ant''.—Antennæ.
as.—Anal style.
bucc.—Mouth parts.
ceph.—Under surface of head.
emb.—Embryo.
en.—Endopodite.
ex.—Exopodite.
gn', *gn''*.—Gnathopods.
l.—Labium.
la.—"Limbe antérieur."
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m.—Mandible.
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mx', *mx''*.—Maxillæ.
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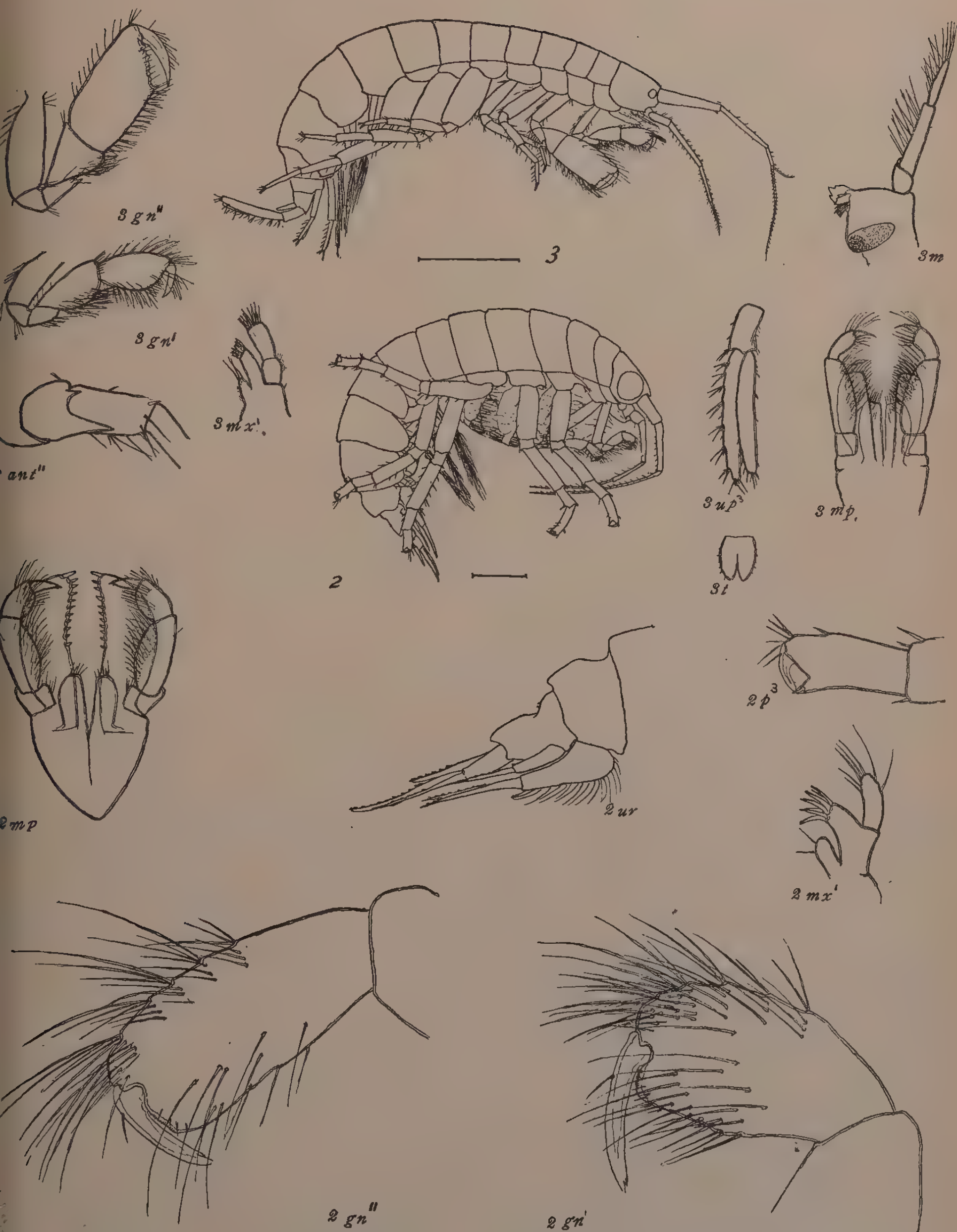
pl.—Abdomen.
pl^{I}, pl^{VI}.—Pleural lamellæ.
plp.—Pleopod.
up.—Uropod.
ur.—Urosome.
t.—Telson.

I, *II*, *III*, *IV*.—Mouth parts of embryo (see text).



V. T. C. ad nat. del.

PLATE XXXIII.

PLATE XXXIII.

Fig. 4. **Amphithoë humeralis** Stimpson.

Reference Letters.

ant'.—Antennules.
ant''.—Antennæ.
as.—Anal style.
bucc.—Mouth parts.
ceph.—Under surface of head.
emb.—Embryo.
en.—Endopodite.
ex.—Exopodite.
gn', *gn''*.—Gnathopods.
l.—Labium.
la.—"Limbe antérieur."
lp.—"Limbe postérieur."
lbr.—Labrum.
m.—Mandible.
mp.—Maxilliped.
mx', *mx''*.—Maxillæ.
p', p^2, etc.—Pereiopods.
pl.—Abdomen.
pl^{I}, pl^{VI}.—Pleural lamellæ.
plp.—Pleopod.
up.—Uropod.
ur.—Urosome.
t.—Telson.

I, *II*, *III*, *IV*.—Mouth parts of embryo (see text).

W. T. C. ad nat. del.

PLATE XXXIV.

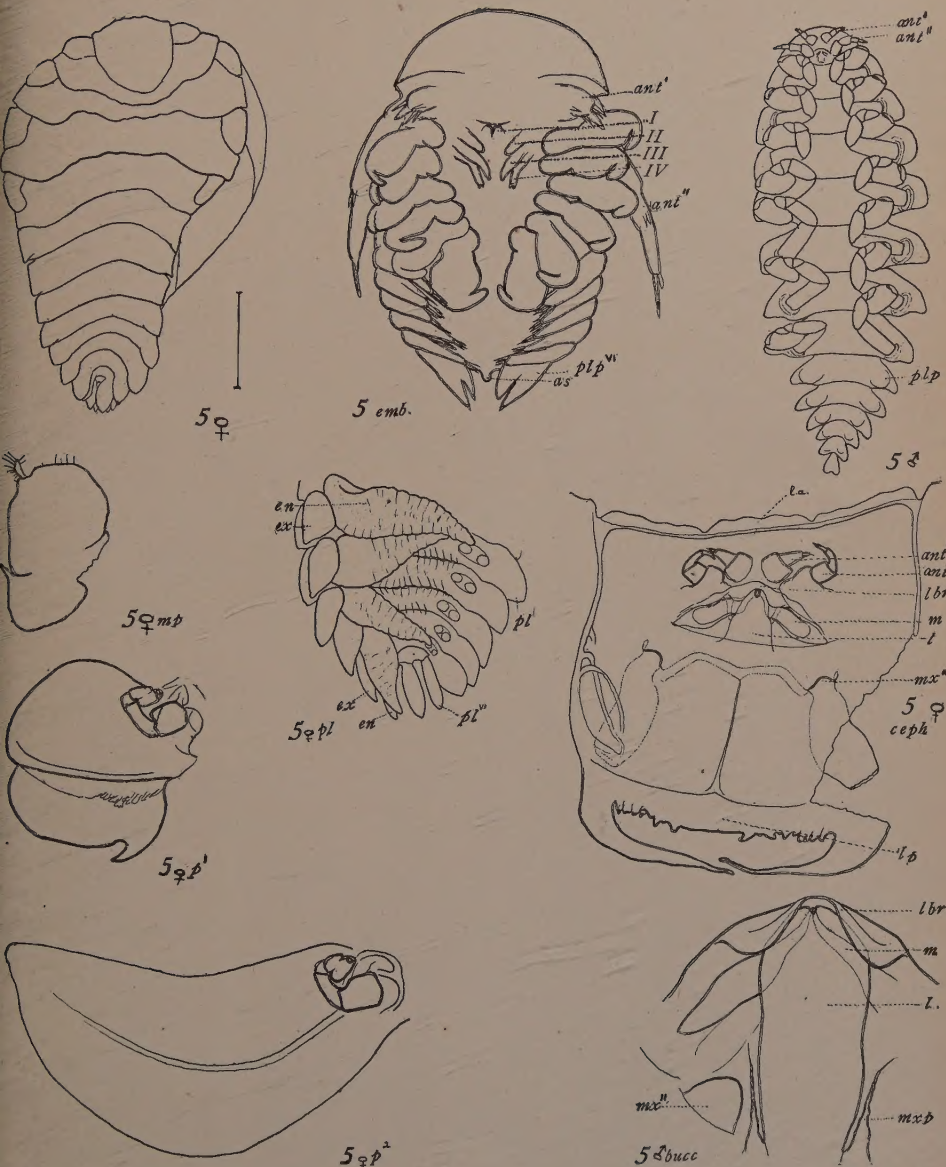
PLATE XXXIV.

Fig. 5. **Pseudione Giardi** n. sp.

REFERENCE LETTERS.

ant'.—Antennules.	*lp.*—"Limbe postérieur."
ant''.—Antennæ.	*lbr.*—Labrum.
as.—Anal style.	*m.*—Mandible.
bucc.—Mouth parts.	*mp.*—Maxilliped.
ceph.—Under surface of head.	*mx'*, *mx''*.—Maxillæ.
emb.—Embryo.	*p'*, *p²*, etc.—Pereiopods.
en.—Endopodite.	*pl.*—Abdomen.
ex.—Exopodite.	pl^{I}, pl^{VI}.—Pleural lamellæ.
gn', *gn''*.—Gnathopods.	*plp.*—Pleopod.
l.—Labium.	*up.*—Uropod.
la.—"Limbe antérieur."	*ur.*—Urosome.
	t.—Telson.

I, II, III, IV.—Mouth parts of embryo (see text).



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CONTENTS OF VOL. XI. PART II.